Sagan Summer Workshop

Poster Pops II
Wednesday, July 23

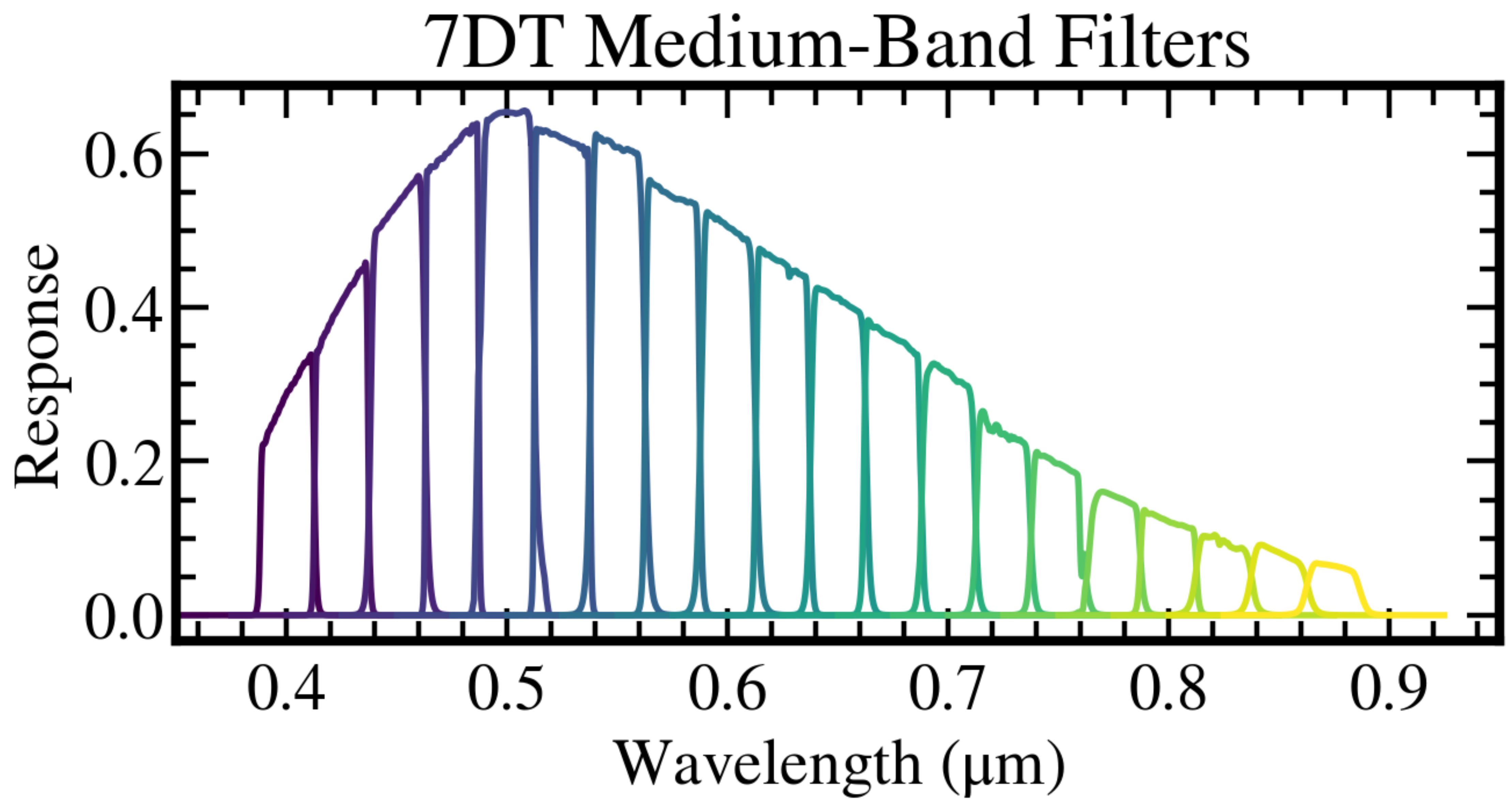
SAGAN SUMMER WORKSHOP

nexsci.caltech.edu/workshop/2025

NExScI

Jangho Bae, Seoul National University, janghobae0604@gmail.com

Transit Spectroscopy Using Medium-Band Filters with the 7-Dimensional Telescope (7DT)



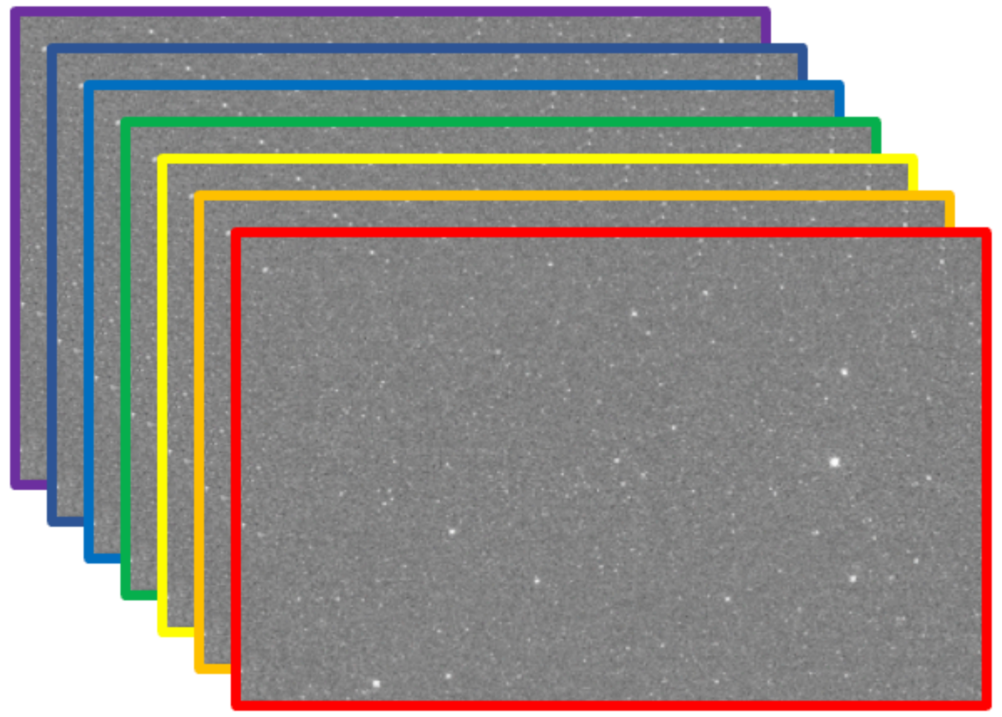
- 7DT: An array of 20 wide-field telescopes.
- Equips **medium-band filters** ($\Delta\lambda = 25\,nm$) and *g, r, i* filters.

Jangho Bae, Seoul National University, janghobae0604@gmail.com

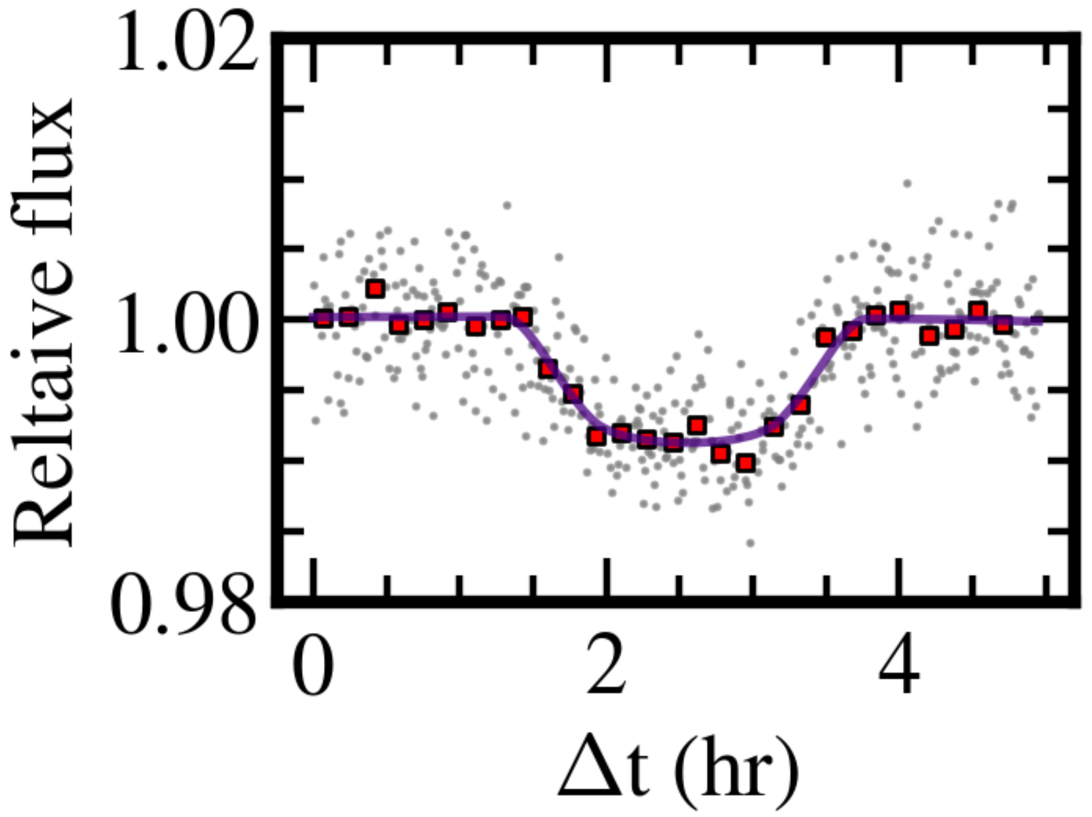
Transit Spectroscopy Using Medium-Band Filters with the 7-Dimensional Telescope (7DT)

- Simultaneous **transit observation with multiple telescopes** with **different filters**
  -> Transmission spectrum!

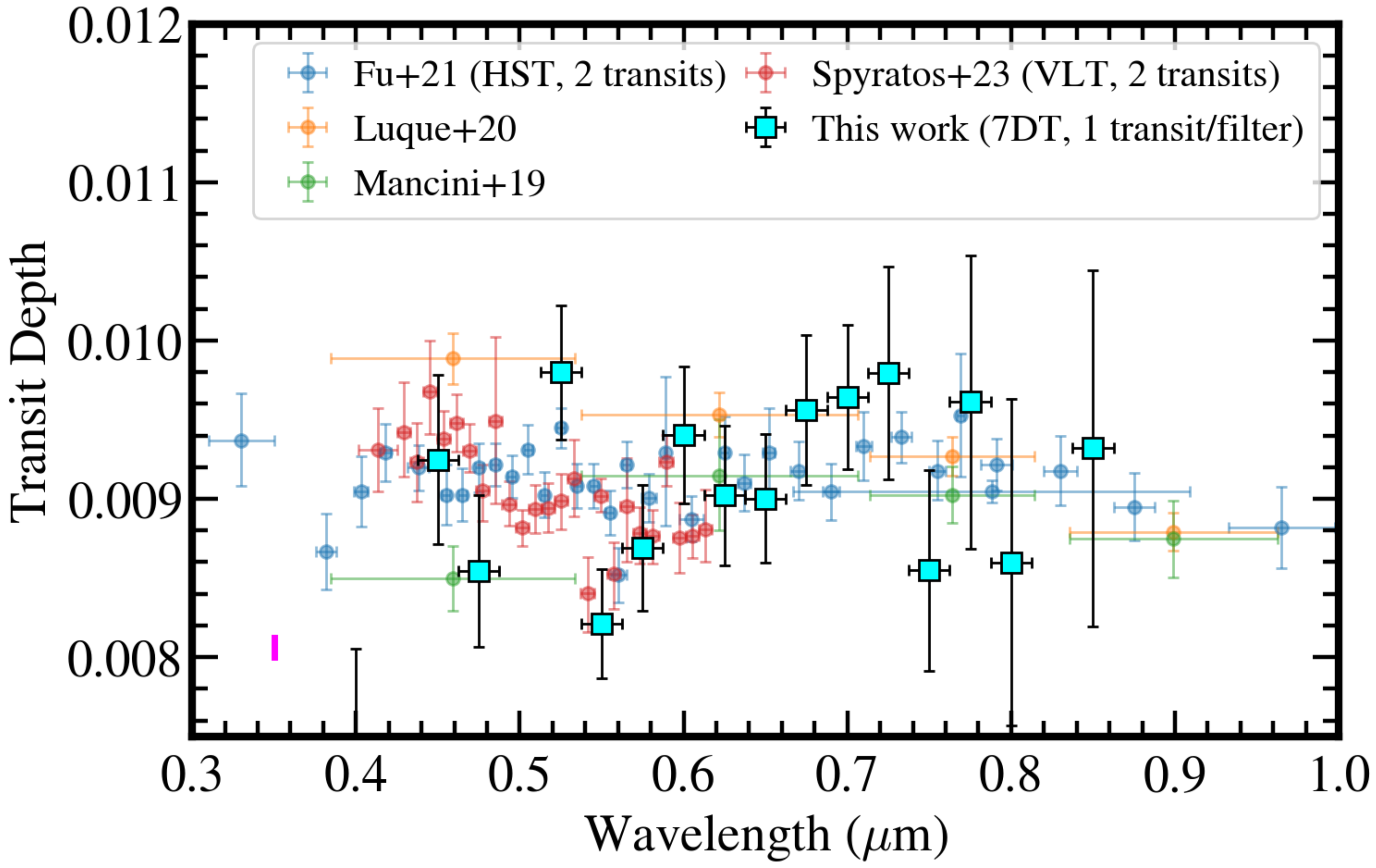
Observed images



Lightcurve fitting for all the observed filters.



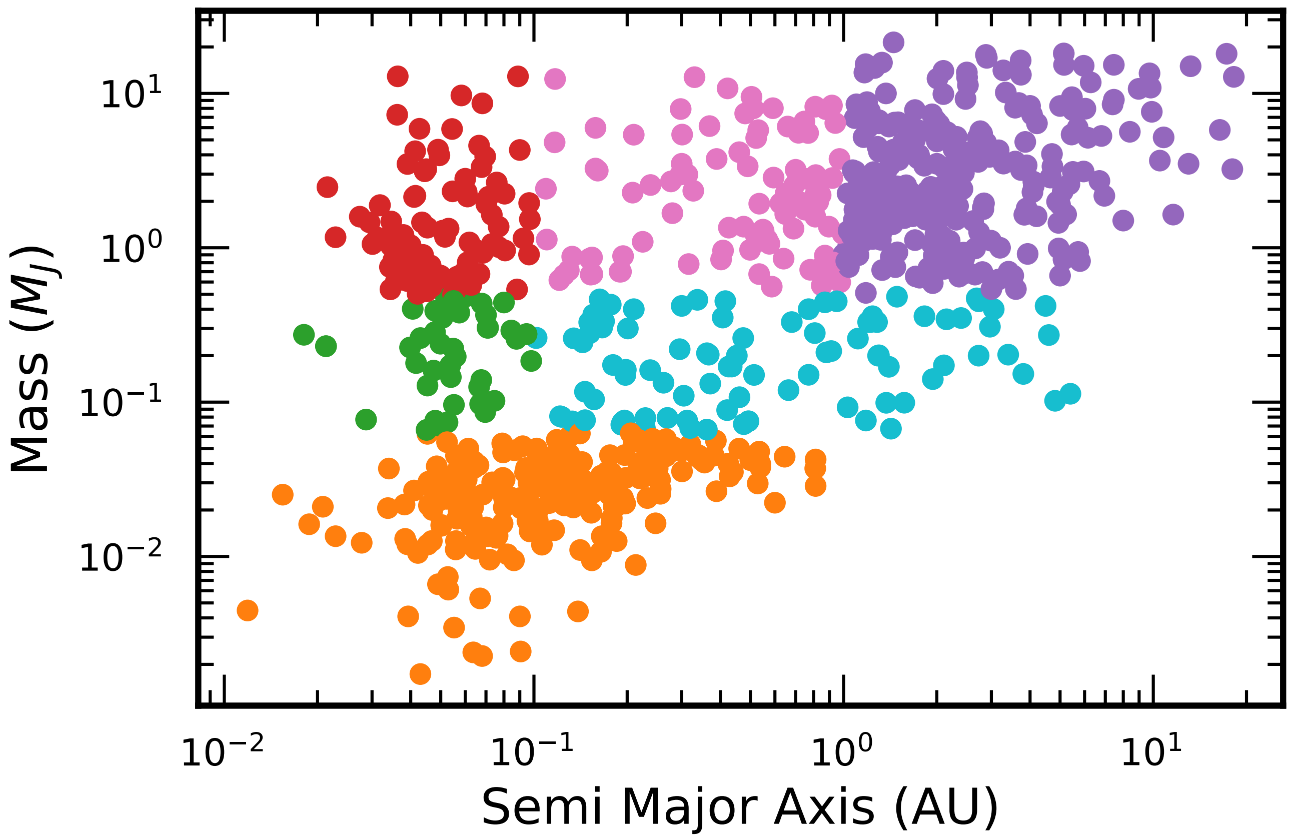
WASP-74 b **transmission specterum**



Multiple telescopes with filter wheels: ***Stable and flexible transit observations!***

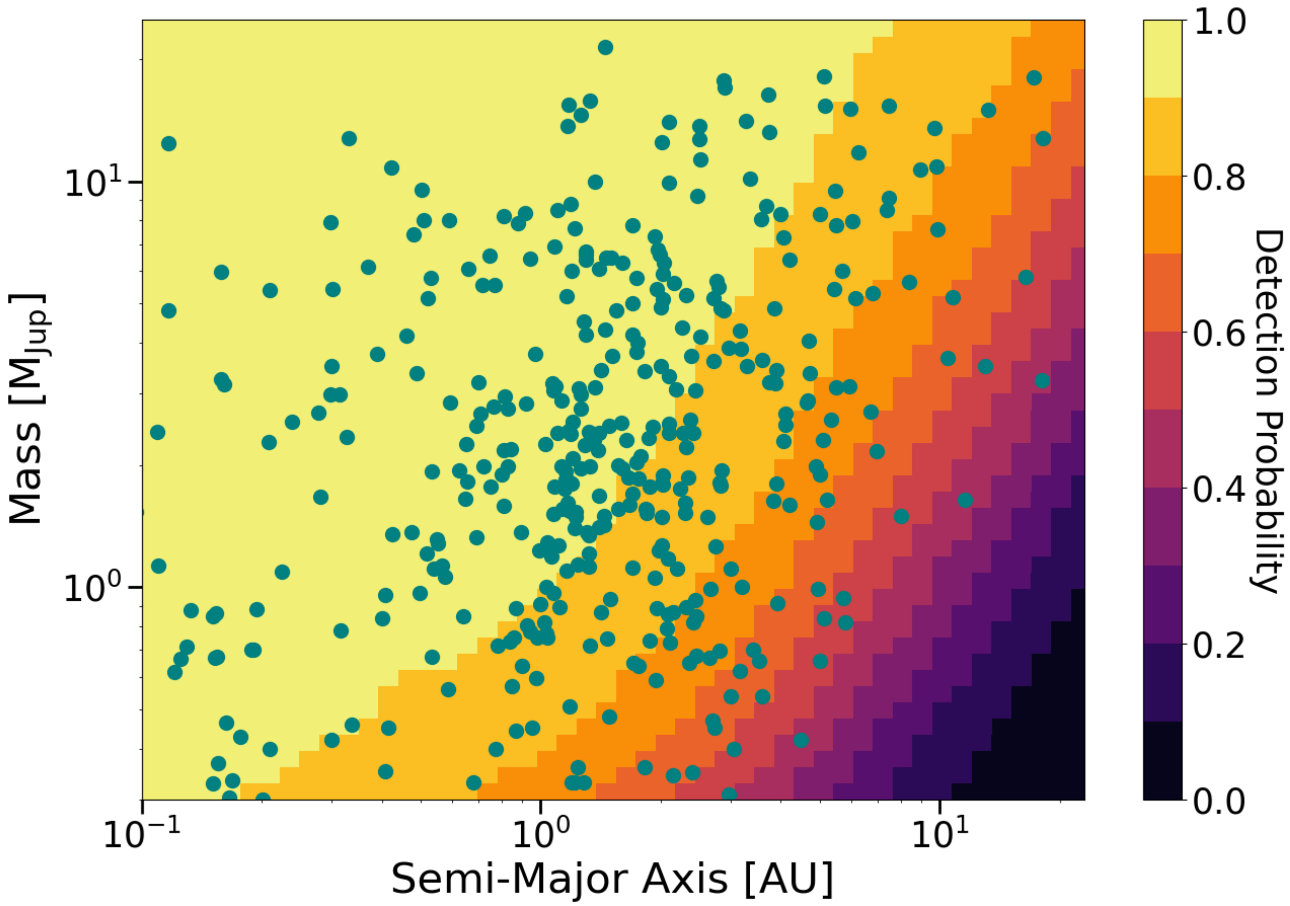
Gas Giants and Their Friends

Joshua Bromley, University of Toronto



We examine the connection between gas giant properties and inner planets with one of the largest samples:

> 1000 Planets & > 600 Systems



We compute completeness maps for each system

On average, we can detect a 1 M_J planet out to 4 AU

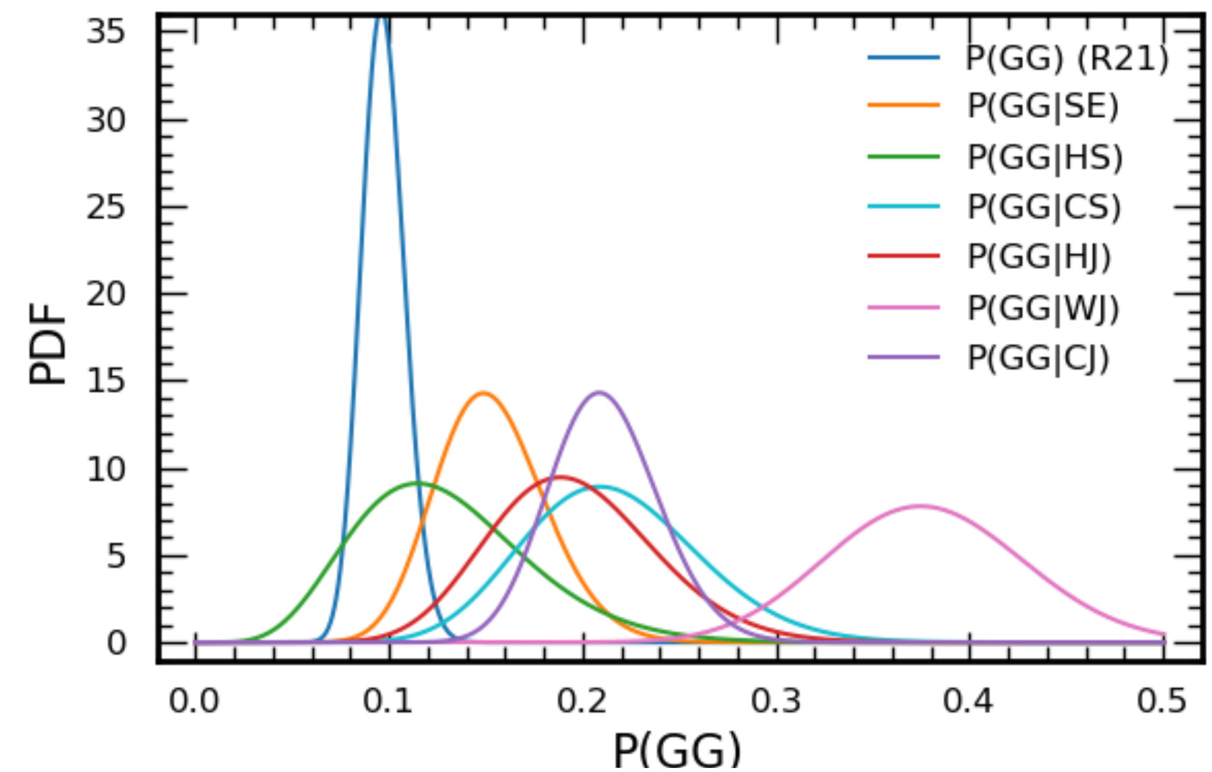
David A. Dunlap Department of Astronomy & Astrophysics
UNIVERSITY OF TORONTO

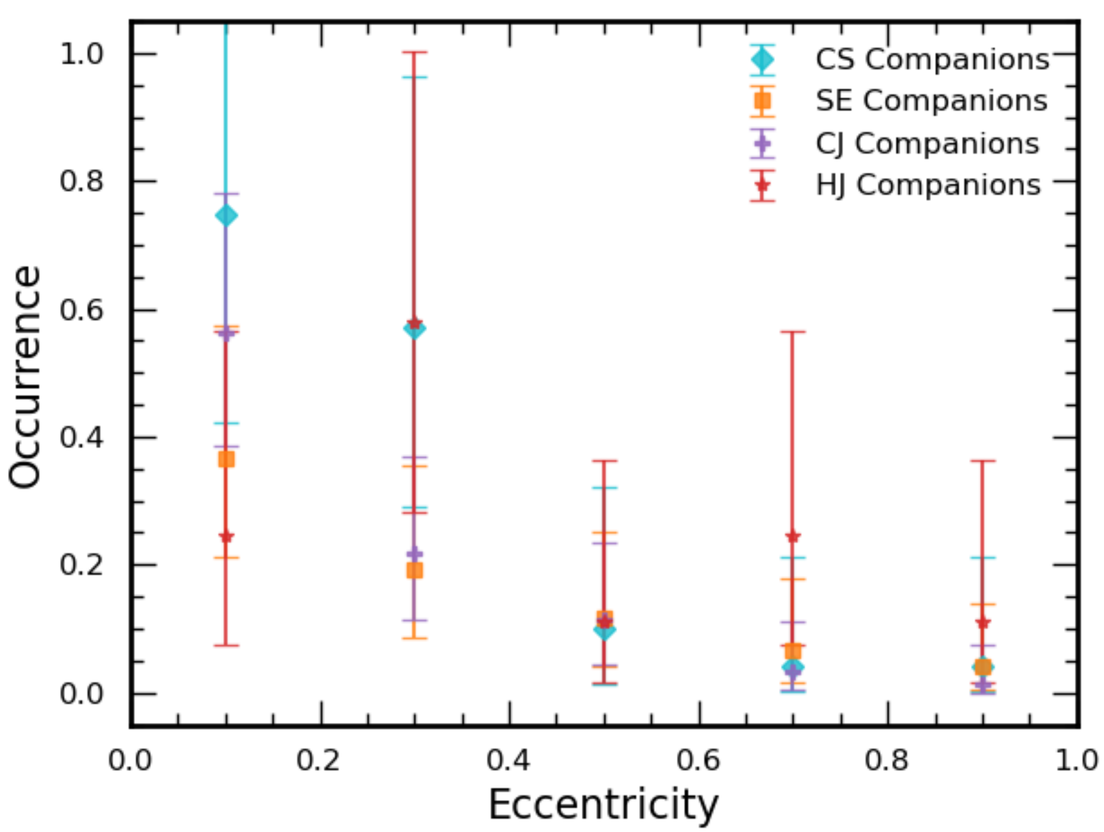
Gas Giants and Their Friends

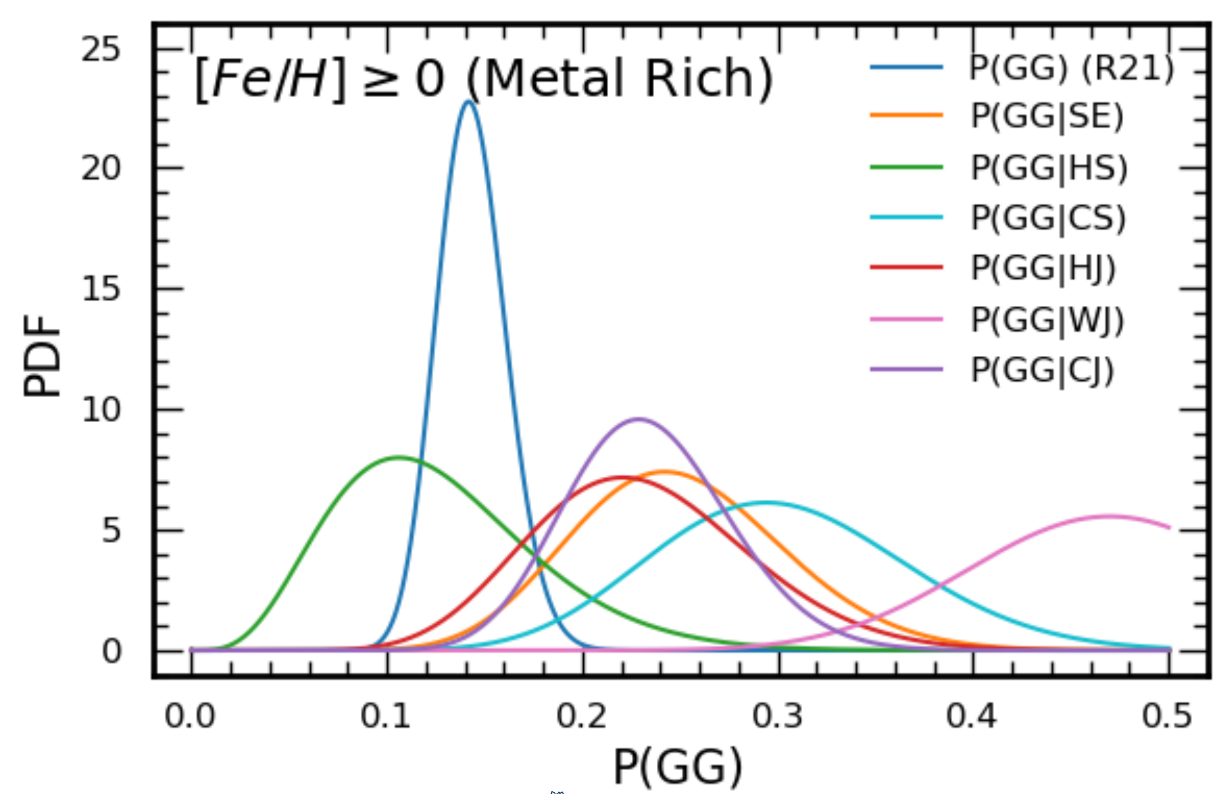
Joshua Bromley, University of Toronto

Gas giants are more likely to occur around other planets than the generic star

We investigate properties that affect this relationship







David A. Dunlap Department of Astronomy & Astrophysics
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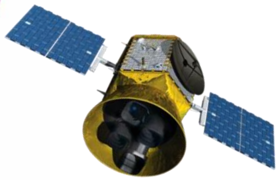


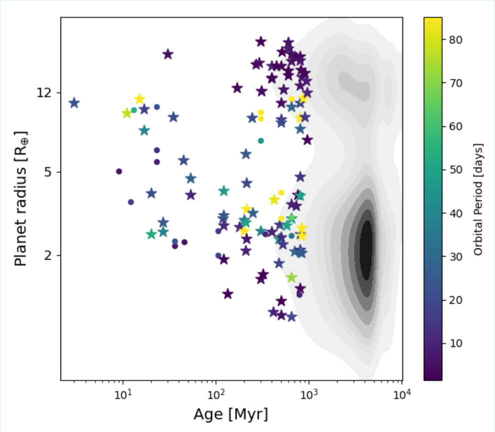
A dedicated search for young transiting planets with TESS

Beatrice Caccherano | b.caccheran@qmul.ac.uk

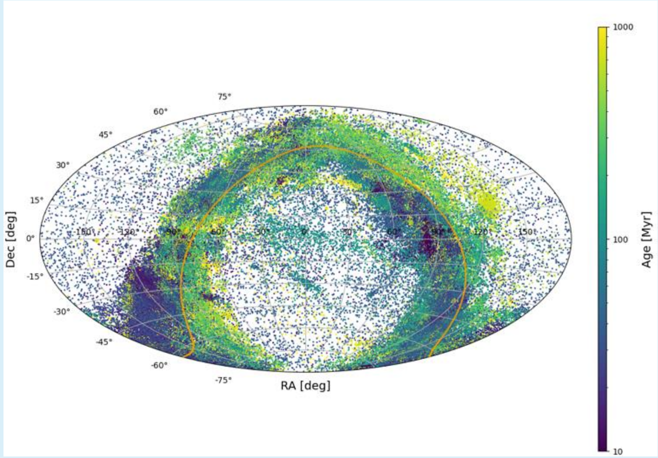
Team: Edward Gillen, Matthew Battley, Cynthia Ho, Andrew Ringham and Alexander Hughes

Queen Mary University of London

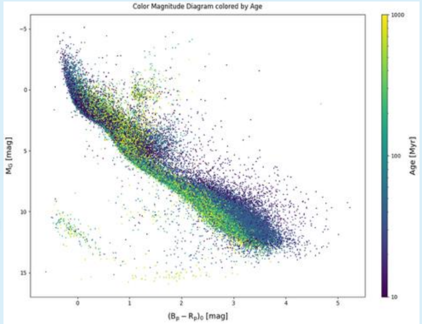
Current status of known young exoplanet

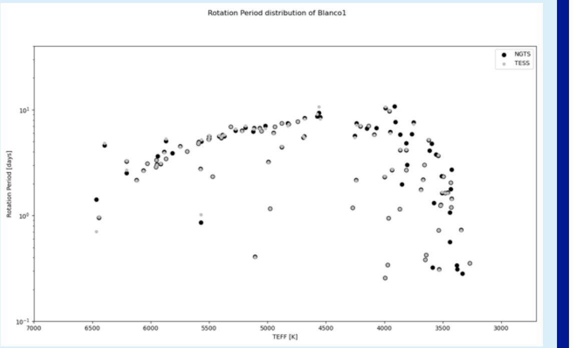


Young stellar catalogue

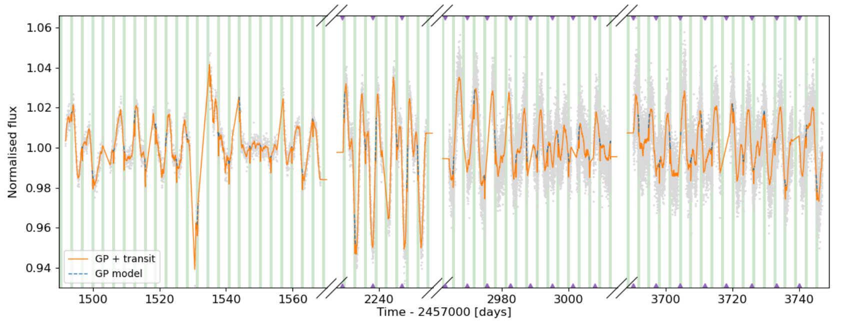


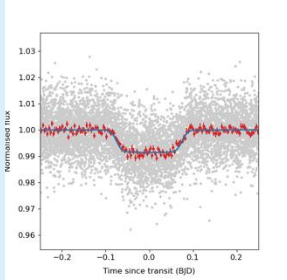
Stellar catalogue analysis



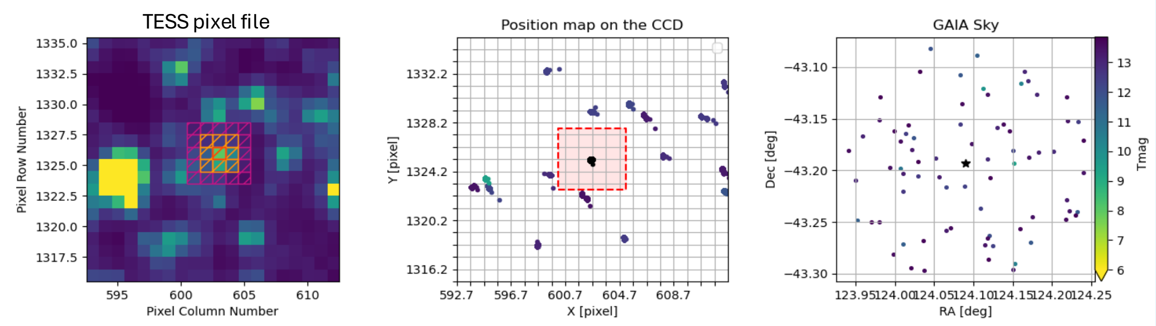


Transit detection strategy: *YSD* and Nuance





Vetting strategy



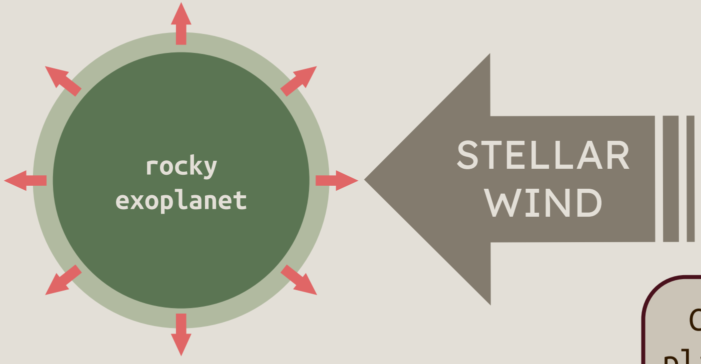
INVESTIGATING **CORE INDUCTION EFFECT** ON **ATMOSPHERIC ESCAPE** AND IMPLICATIONS FOR **HABITABILITY**

BOSTON UNIVERSITY

lrchin@bu.edu

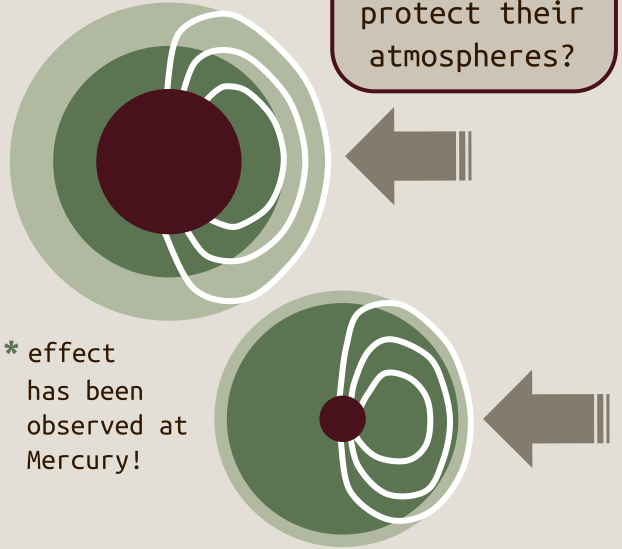
1

What rocky planets are most likely to lose or retain their atmospheres?



2

The **core induction effect*** helps rocky planets with **big conducting cores** produce additional magnetic shielding in response to extreme stellar conditions.



* effect has been observed at Mercury!

Could these planets better protect their atmospheres?

3

Investigate!
Using multispecies MHD model BATS-R-US*

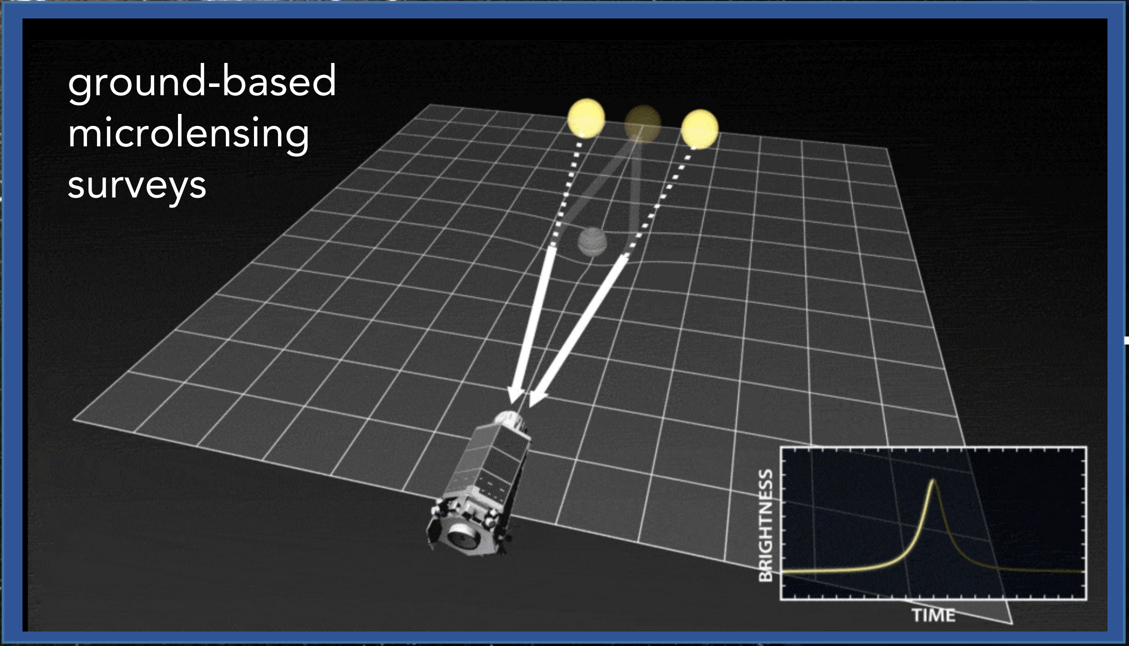
* unofficial logo

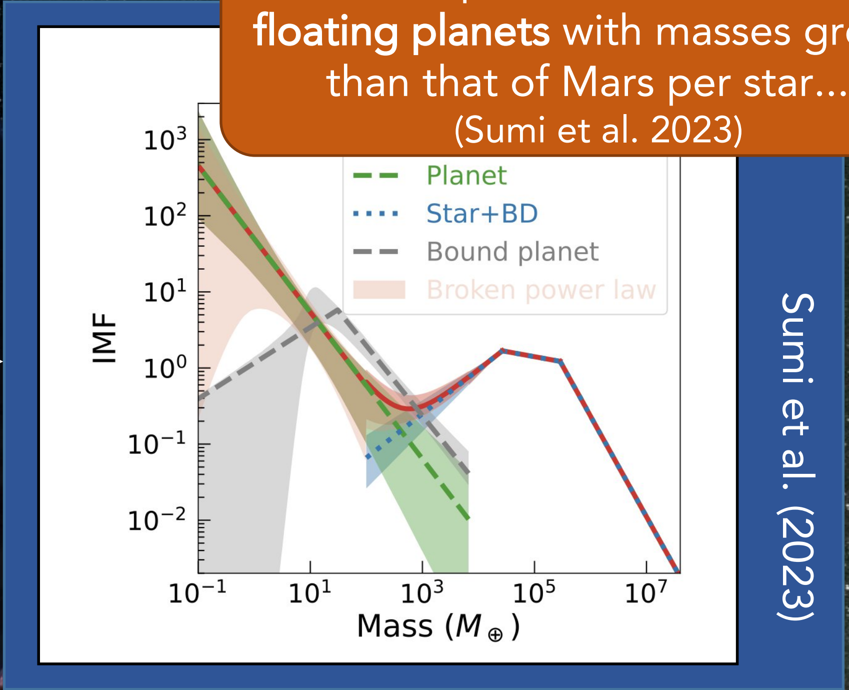
[PRELIMINARY] RESULTS

Just induction effect: smallest core (~0.2 R_P) planet has **~2x higher atmospheric escape rate** than largest core (~0.8 R_P) planet

Self-consistent gravity: difference increases to **~5x**

Ground-based microlensing surveys suggest an immense population of *Earth-mass free-floating planets.*





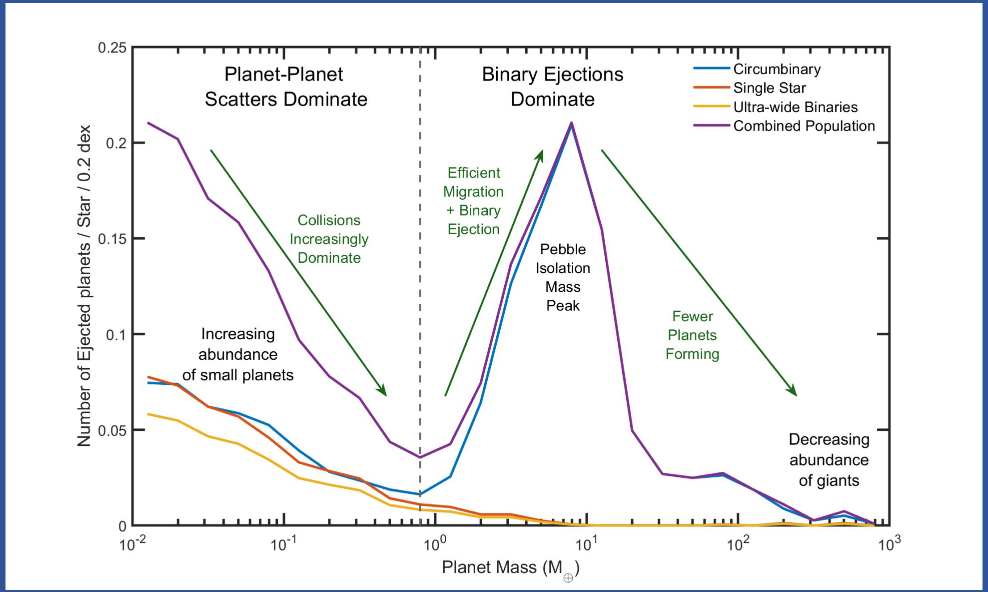
"This implies a total of **21 free-floating planets** with masses greater than that of Mars per star…"
(Sumi et al. 2023)

Free-floating planets may constitute the *largest demographic of exoplanets in the Galaxy.*

William DeRocco (derocco@umd.edu)

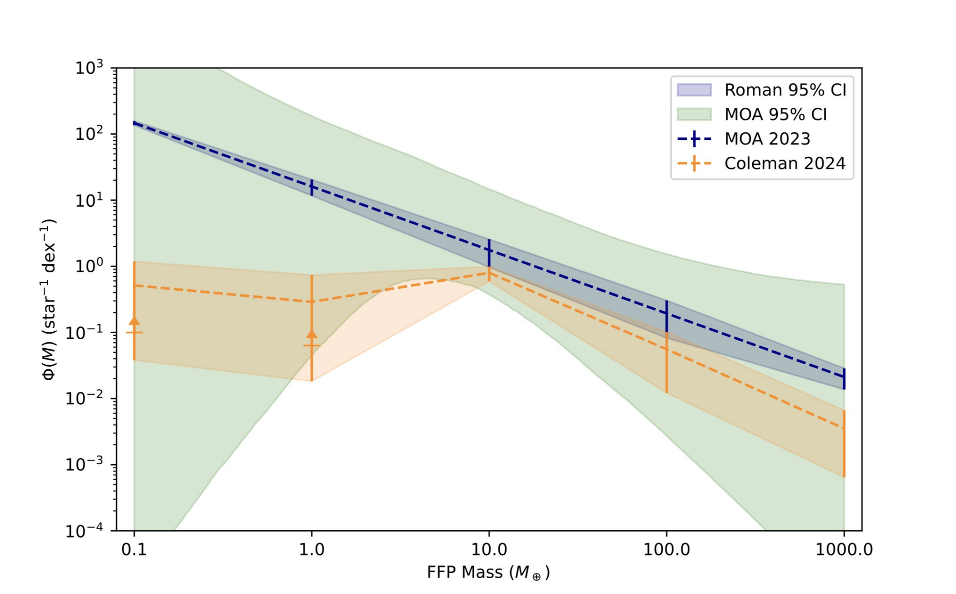
Does this make sense from planet formation theory?

Coleman+DeRocco (2025)



What will upcoming observations reveal about this demographic?

DeRocco et al. (2025)



theory

observation

The Roman Space Telescope provides an unprecedented opportunity to **discover the origins and abundance of free-floating planets in the Galaxy!**

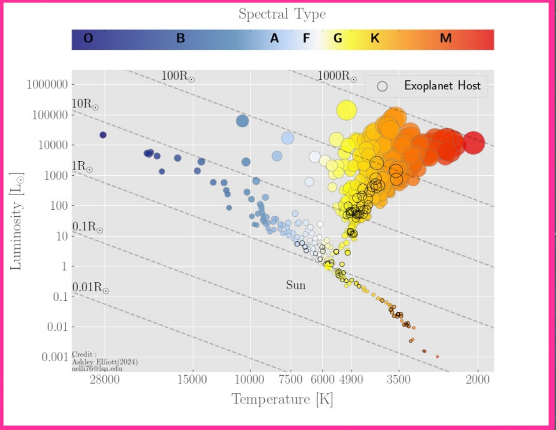
William DeRocco (derocco@umd.edu)

"Know thy star, know thy planet."
Using long baseline optical/near-IR interferometry (LBOI) to study exoplanet host stars

★Almost all exoplanet properties are directly related to their host star properties.

★LBOI: the technique of combining light from multiple telescopes that are separated by long distances, resulting in high-resolution capabilities (sub-mas)

★LBOI allows us to **directly** measure a star's angular diameter, reaching precisions of <1%.



Direct Measurements:
★Angular diameter
★Bolometric Flux
★Parallax

→

Derived Stellar Properties:
★Effective temperature
★Luminosity
★Radius

→

Modeled Stellar Properties:
★Age
★Mass

→

Exoplanet Characterization

Ashley Elliott

LSU Department of Physics & Astronomy

For more info on the really cool HR diagram, scan here:

"Know thy star, know thy planet."
Using long baseline optical/near-IR interferometry (LBOI) to study exoplanet host stars

The HD 219134 System:

The Star:

★K3V dwarf star

★~6.5 parsecs away

The Planets:

★6* planets

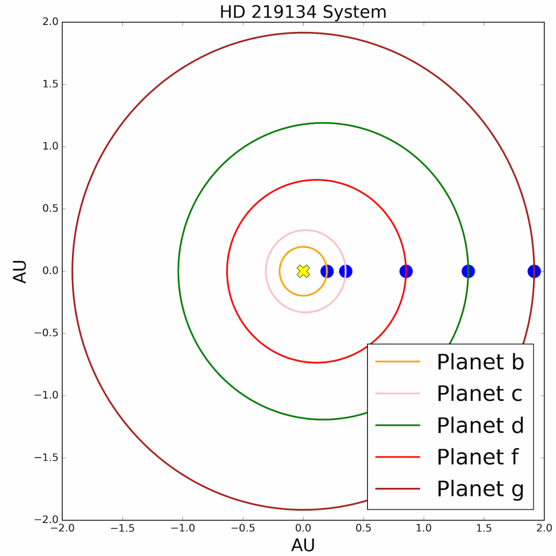
★Planets b and c are transiting exoplanets

★Planets b, c, d, f, g, and h are all RV planets

* Planet f's existence is controversial

Want to see the results?:

Come check out my poster!



Ashley Elliott

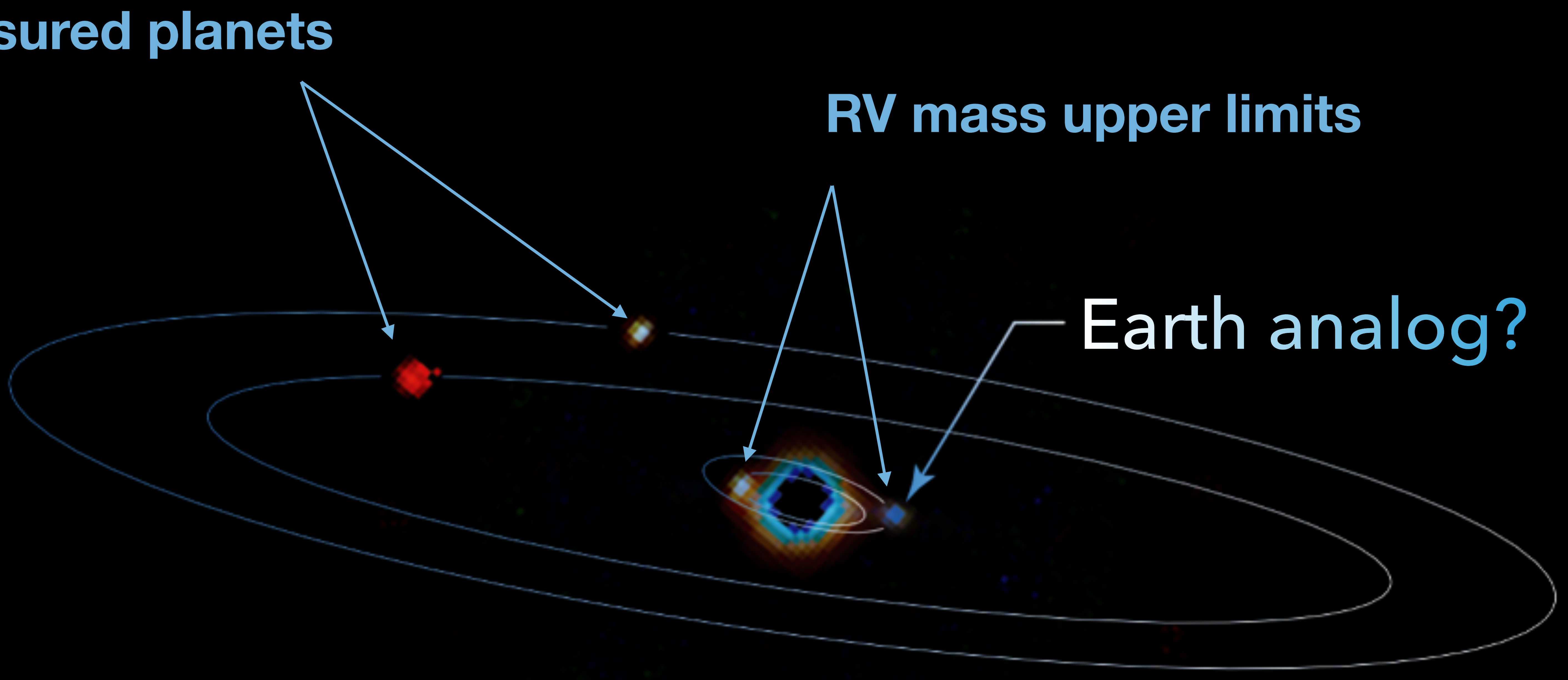
LSU Department of Physics & Astronomy

Tl;dr: Precursor RV Survey for HWO Target Stars

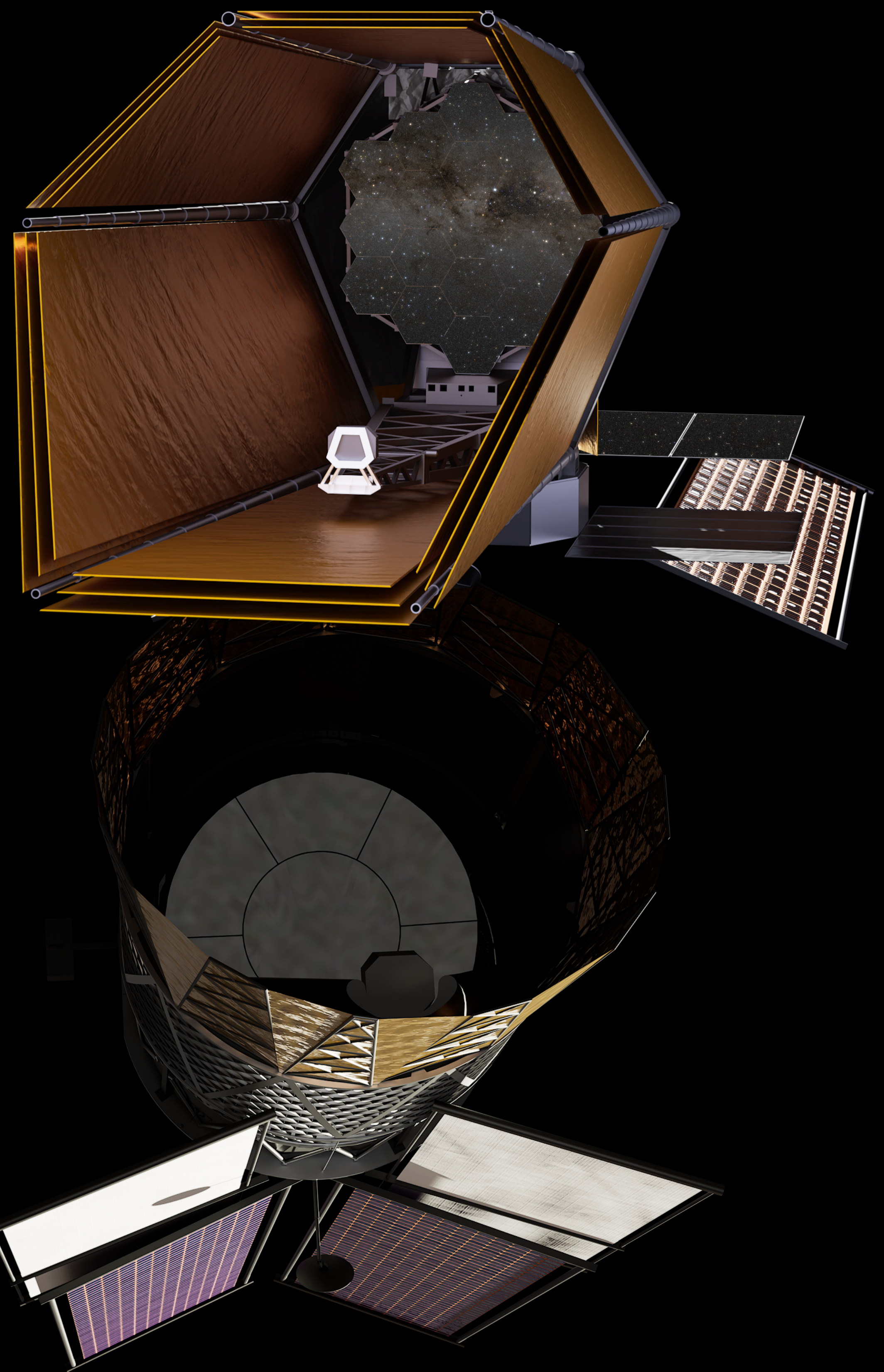
SPORES
System Properties & Observational Reconnaissance for Exoplanet Studies with HWO

Caleb Harada* (UC Berkeley), Courtney Dressing (UCB), Stephen Kane (UCR), & collaborators

**is looking for a job!*



Simulated image of a Solar System analog 30 light-years away, as captured by a large UV/O/NIR space telescope like HWO [STScI, NASA GSFC].



Notional exploratory analytic cases (EACs) for HWO

Tl;dr: Precursor RV Survey for HWO Target Stars

SPORES
System Properties & Observational Reconnaissance for Exoplanet Studies with HWO

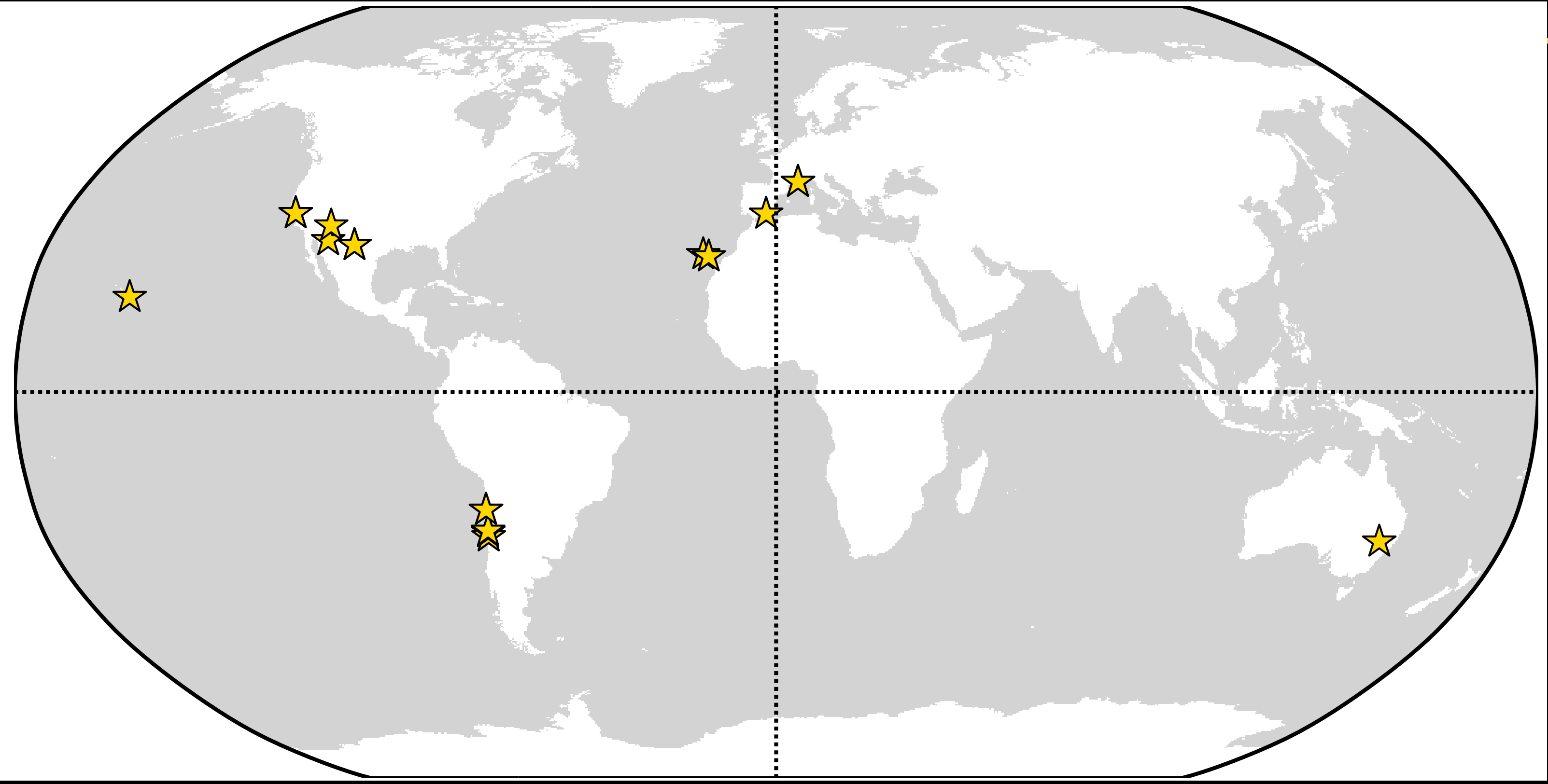
153,490 public RV measurements

141 HWO (preliminary) target stars

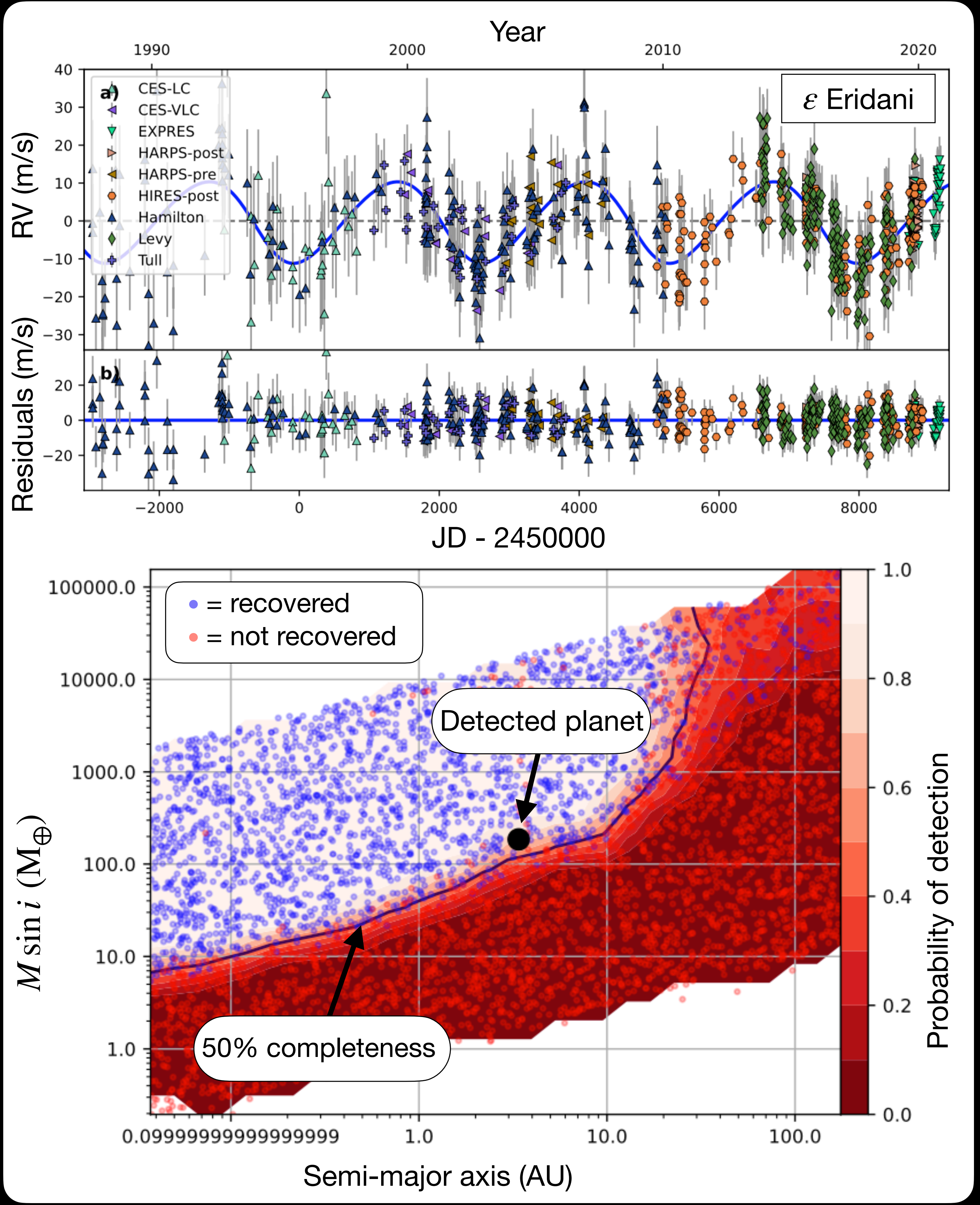
27 spectrographs around the world

36 years of observations

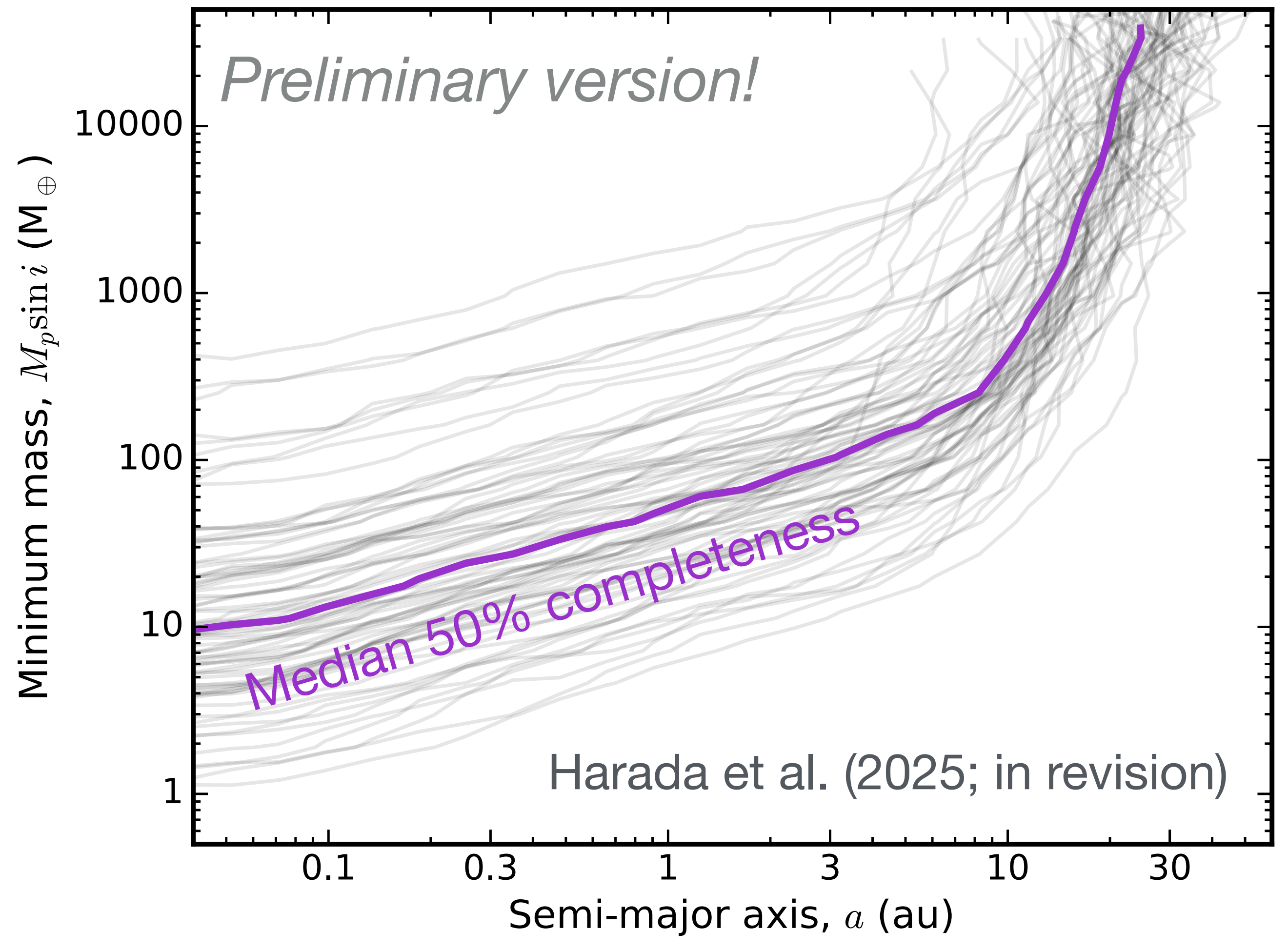
70 undergraduate volunteers



RV Search & Completeness



Planet Detections & Mass Limits



Come to my poster or email me!

Measuring Surface Energies with Calorimetry to Examine Nucleation Rates

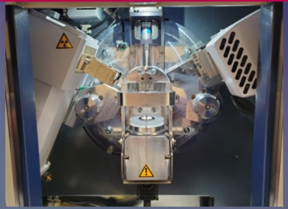
ThermotU Laboratory @Arizona State University
School of Earth and Space Exploration
Arizona State University

Nanoparticle Synthesis

Each chemical species has a different synthesis method. For ZnS, nano-sphalerite was synthesized using the hydrothermal method. Nano-enstatite was synthesized using the sol-gel method.

Nanoparticle Characterization

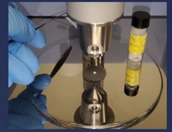
Thermogravimetry and Differential Scanning Calorimetry (TG – DSC): Setaram Labsys Evo



Powder X-Ray Diffraction (PXRD): Bruker D2 bench top diffractometer

Scanning Electron Microscopy, Scanning Transmission Electron Microscopy, Transmission Electron Microscopy

Brunnauer-Emmet-Teller (BET) Measurements: N_2 adsorption to measure the surface area of the nanoparticles - measured at 77 K using a 10-point BET technique on the analysis port of a Micromeritics ASAP 2020



FTIR Spectroscopy: Bruker Vertex 70 spectrometer

Oxide Melt Solution Calorimetry

High temperature oxide melt solution calorimetry is performed using a Tian-Calvet twin calorimeter AlexSYS at 1073 K in a sodium molybdate or lead borate solvent. The bulk and nano samples of the species are methodically dropped into the solvent to obtain the drop solution enthalpy, ΔH_{ds}. The nano sample are water-corrected for in the thermochemical cycles. The surface energy is then given by ΔH_{ds} (bulk)-ΔH_{ds}(nano water corrected)(kJ/mol) / surface area (m^2/mol).

Surface energy =

$$\frac{\Delta H_{ds}(\text{bulk}) - \Delta H_{ds}(\text{nano})(\text{kJ/mol})}{\text{surface area }(\text{m}^2/\text{mol})}$$

ΔH_{ds} = drop solution enthalpy

ARIZONA STATE NASA 80NSSC22K1640

Silicate Nucleation Rates in WASP 17-b and VHS 1256b with Measured Surface Energies

ThermotU Laboratory @Arizona State University
School of Earth and Space Exploration, Arizona State University

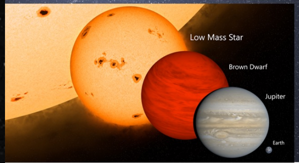
VHS 1256b

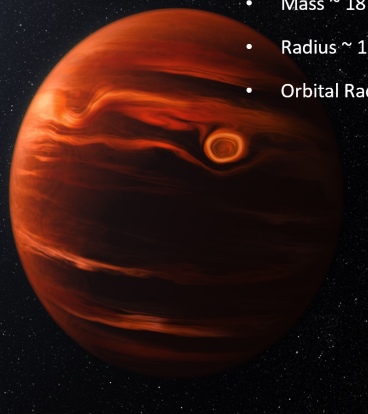
Silicates in Atmosphere

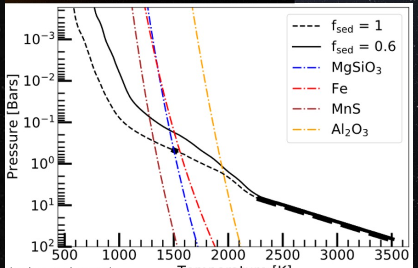
- Best fit model (Miles et al. 2022)
  - Enstatite
  - Forsterite
  - Quartz

Brown Dwarf

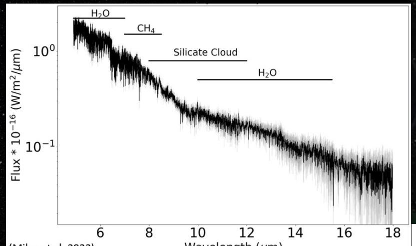
- 70 light years from earth
- Mass ~ 18 M_J
- Radius ~ 1.5 R_J
- Orbital Radius = 156 AU
- Orbital Period = 10,000 yrs
- Orbital Day = 22 hrs
- Age ~ 140 Myr
- T_{eq} ~ 1,110 K (830 °C)





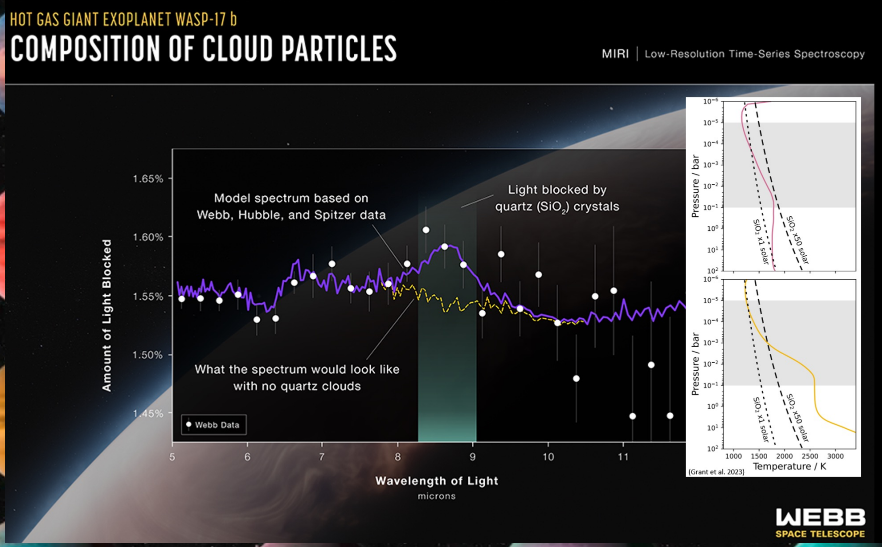


(Miles et al. 2022)



(Miles et al. 2022)

SiO_2 Clouds Detected on Hot Jupiter WASP 17b

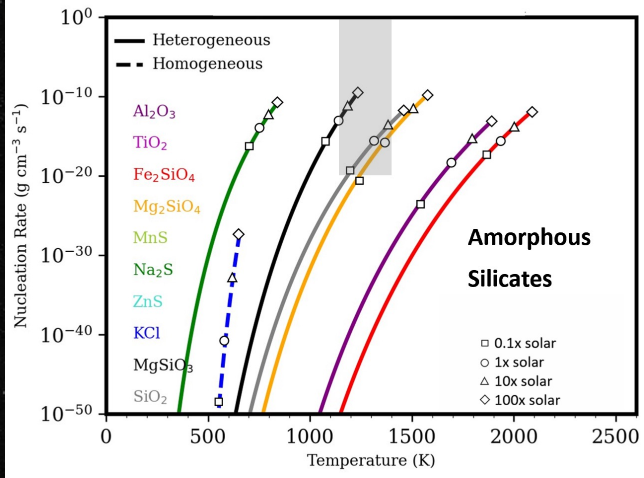


(Grant et al. 2023)

Hot 'Puffy' Jupiter

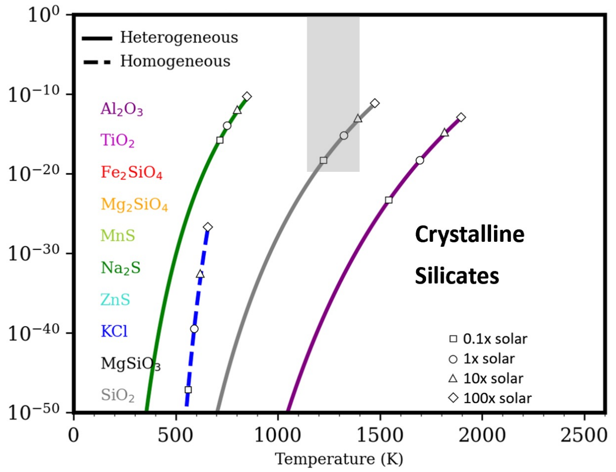
- Tidally locked
- T_{eq} = 1771 K
- 1,324 light years from earth
- Mass = 0.477 M_J
- Radius = 1.932 R_J
- Orbital Radius = 0.05 AU
- Orbital Period = 3.735 days
- **SiO_2 clouds at 0.1 mbar and ~1500 K**

Nucleation Code Results for VHS 1256b



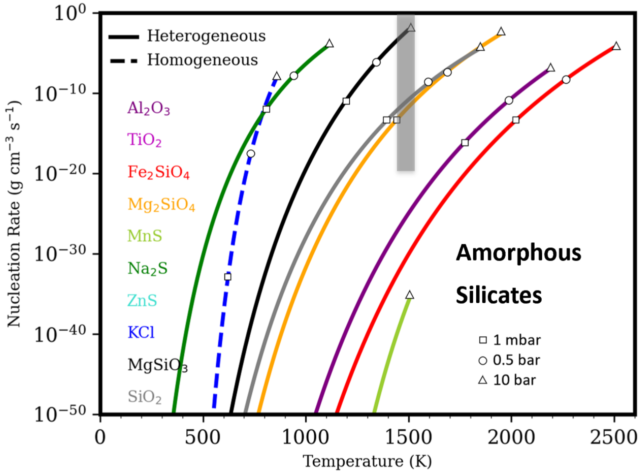
Amorphous species nucleation rates as a function of temperature for a hot exoplanet at atmospheric pressure of 0.1 mbar with varying solar metallicities

At 0.1 mbar there may not be enough material for condensation of Mg-rich silicates



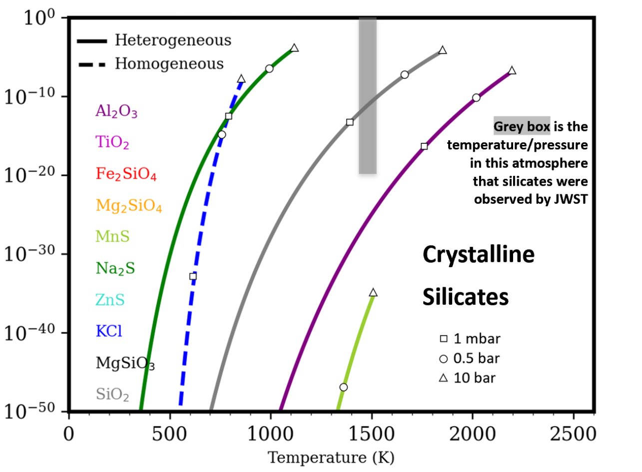
Nucleation results when the *crystalline* silicate surface energies are used

Crystalline silica is the dominant nucleating material in this atmosphere



Results of the public nucleation code provided by Gao et al. (2018) for select cloud species of a hot giant exoplanet with 1x solar metallicity

Enstatite, quartz and forsterite dominate nucleation at the equilibrium temperature if they INITALLY nucleate as *amorphous*



Nucleation results when the *crystalline* silicate surface energies are used

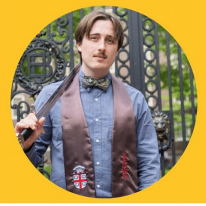
Because Mg-rich silicates were seen by Webb they must initially condense as amorphous

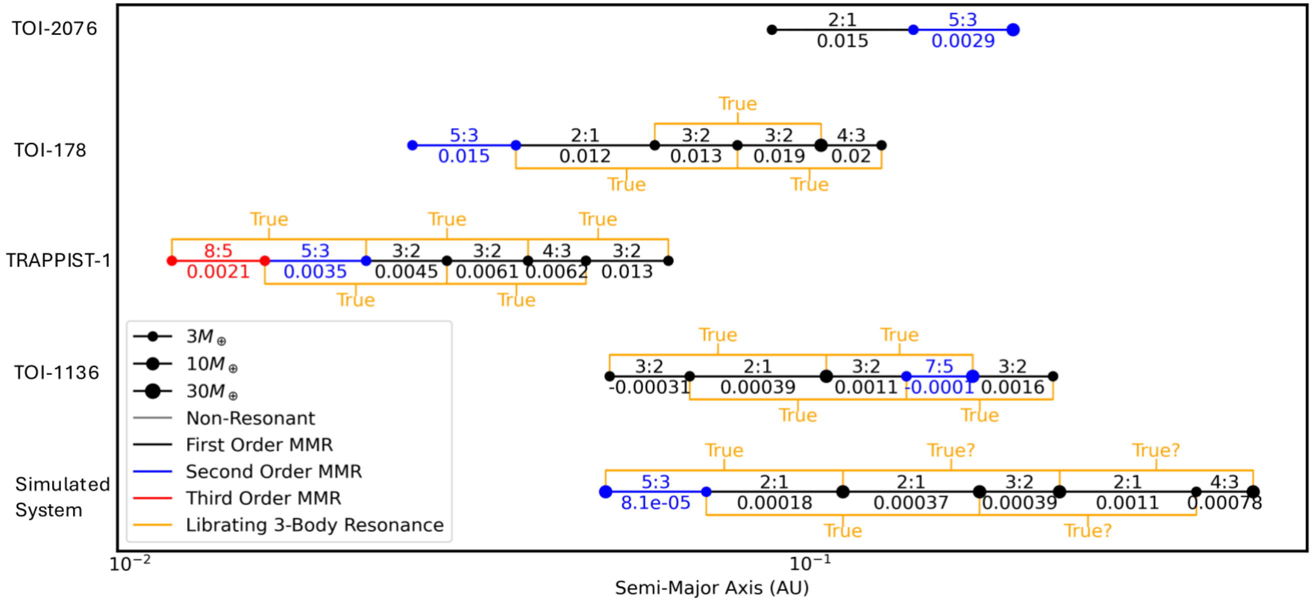
Higher-Order Mean-Motion Resonances Can Form in Type-I Disk Migration

School of Earth and Space Exploration
Arizona State University

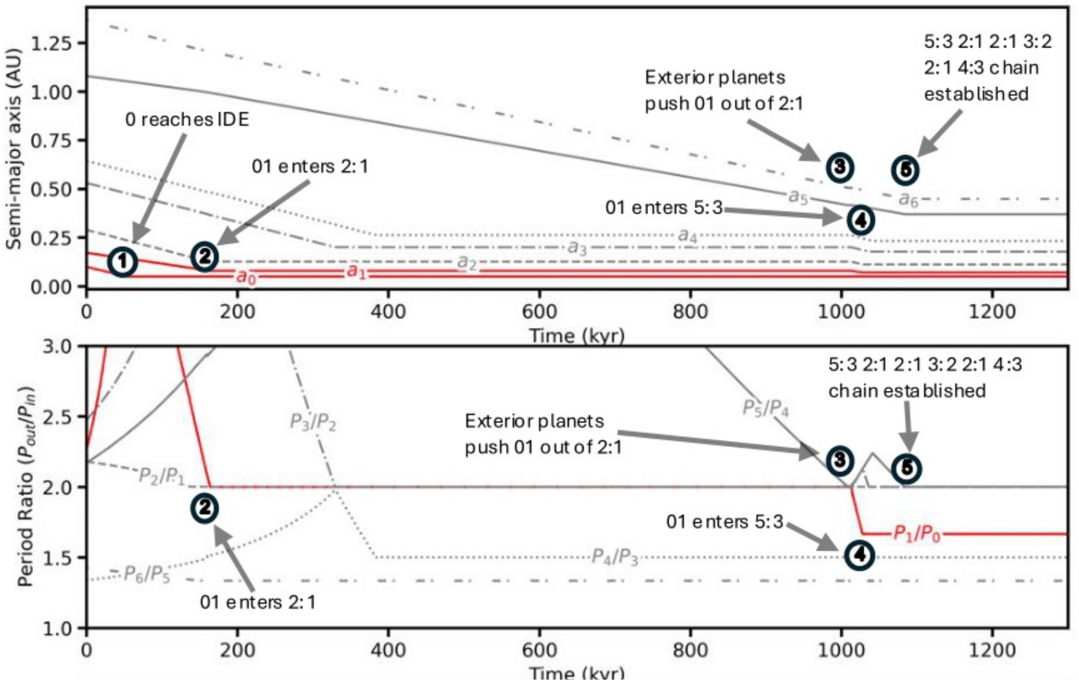
Finnegan Keller [1, 2, 3] Fei Dai [3, 4, 5] Wenrui Xu [6]

[1]School of Earth and Space Exploration, Arizona State University [2]Department of Physics, Brown University [3]Institute for Astronomy, University of Hawai'i
[4]Division of Geological and Planetary Sciences, California Institute of Technology [5]Department of Astronomy, California Institute of Technology
[6]Center for Computational Astrophysics, Flatiron Institute





- Mean-Motion Resonance (MMR): two planets develop orbital periods (or mean-motions) close to an integer ratio.
- MMR Order: difference in the integers that define the ratio (2:1 is first-order, 5:3 is second order, 8:5 is third-order).
- Kepler-like planets could have formed in MMR through disk migration. The weakness of higher-order MMRs could aid the disruption of initially resonant Kepler-like systems.
- A number of multi-planet planetary systems contain planet pairs near higher-order resonances (see above).



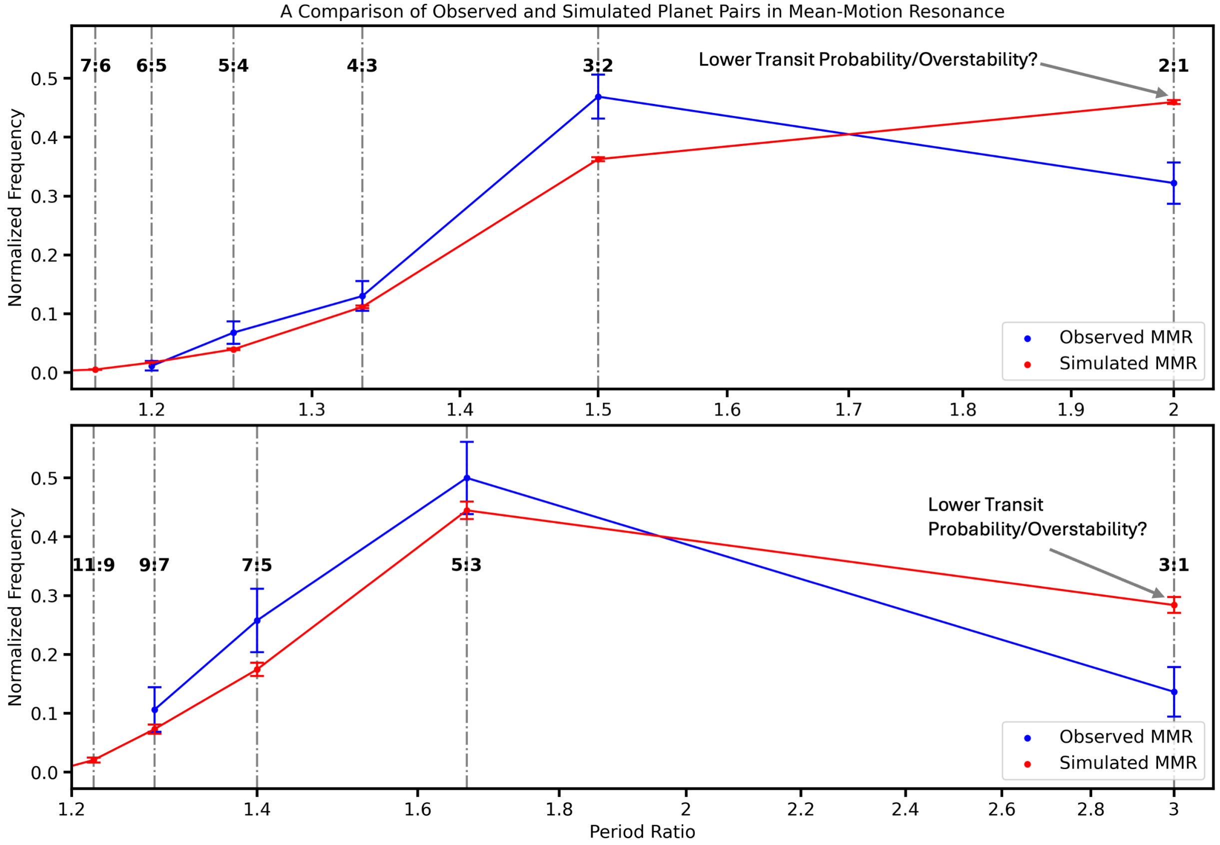
- We performed ~6000 N-body emulations of disk migration simulations, which did indeed produce higher-order MMRs.
- Above, an example simulation that resulted in a 5:3 second-order MMR (red) is plotted.
- Note that the planets that ended up in the higher-order resonance initially engaged in a first-order one.

Higher-Order Mean-Motion Resonances Can Form in Type-I Disk Migration

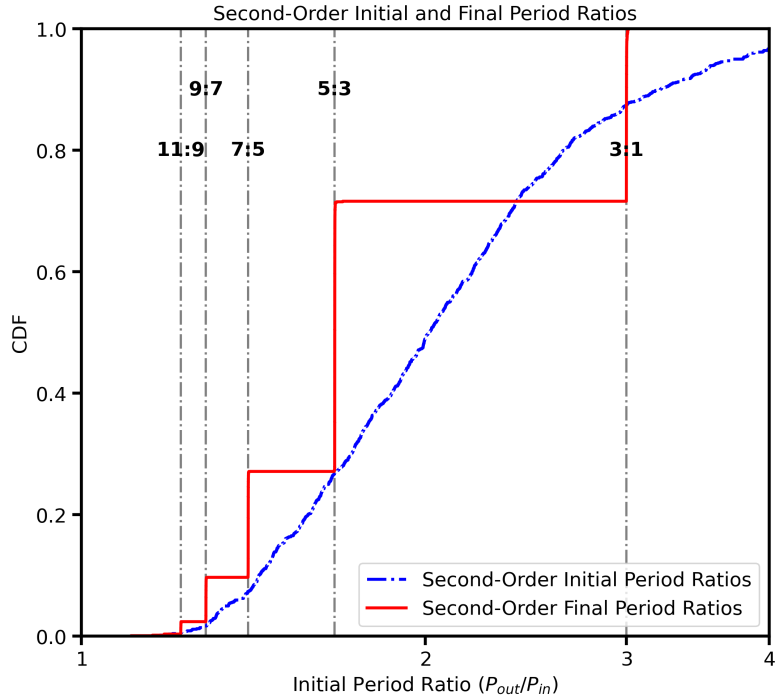
School of Earth and Space Exploration
Arizona State University

Finnegan Keller [1, 2, 3] Fei Dai [3, 4, 5] Wenrui Xu [6]

[1]School of Earth and Space Exploration, Arizona State University [2]Department of Physics, Brown University [3]Institute for Astronomy, University of Hawai'i
[4]Division of Geological and Planetary Sciences, California Institute of Technology [5]Department of Astronomy, California Institute of Technology
[6]Center for Computational Astrophysics, Flatiron Institute

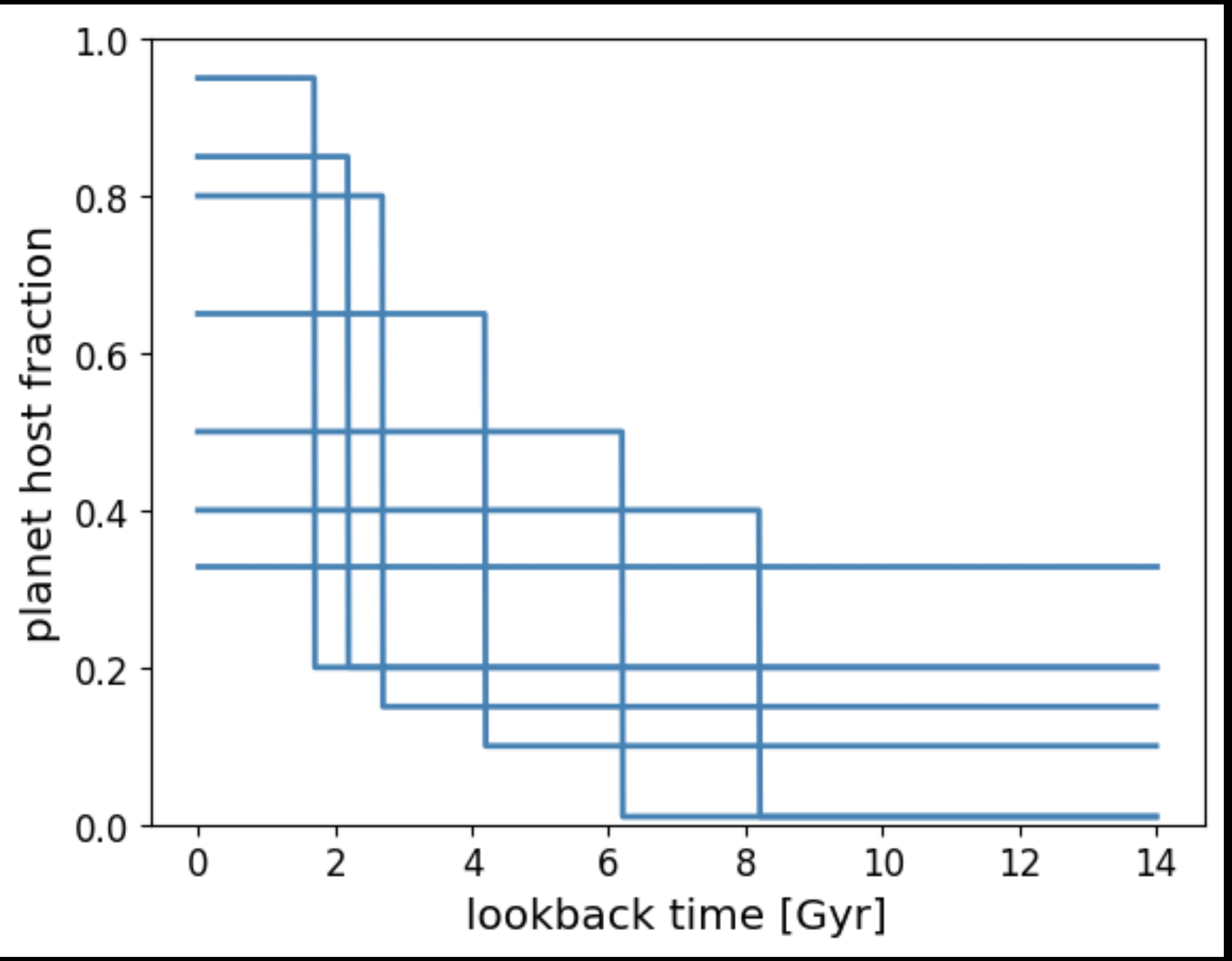


- Produced fractions of higher-order resonance depend on the range of disk surface density we assumed (10-10,000 g/cm^2).
- The relative proportion of individual resonances (e.g. the fraction of planets in 5:3 vs. 7:5 MMR) in our simulations are in good agreement with observation (see above).



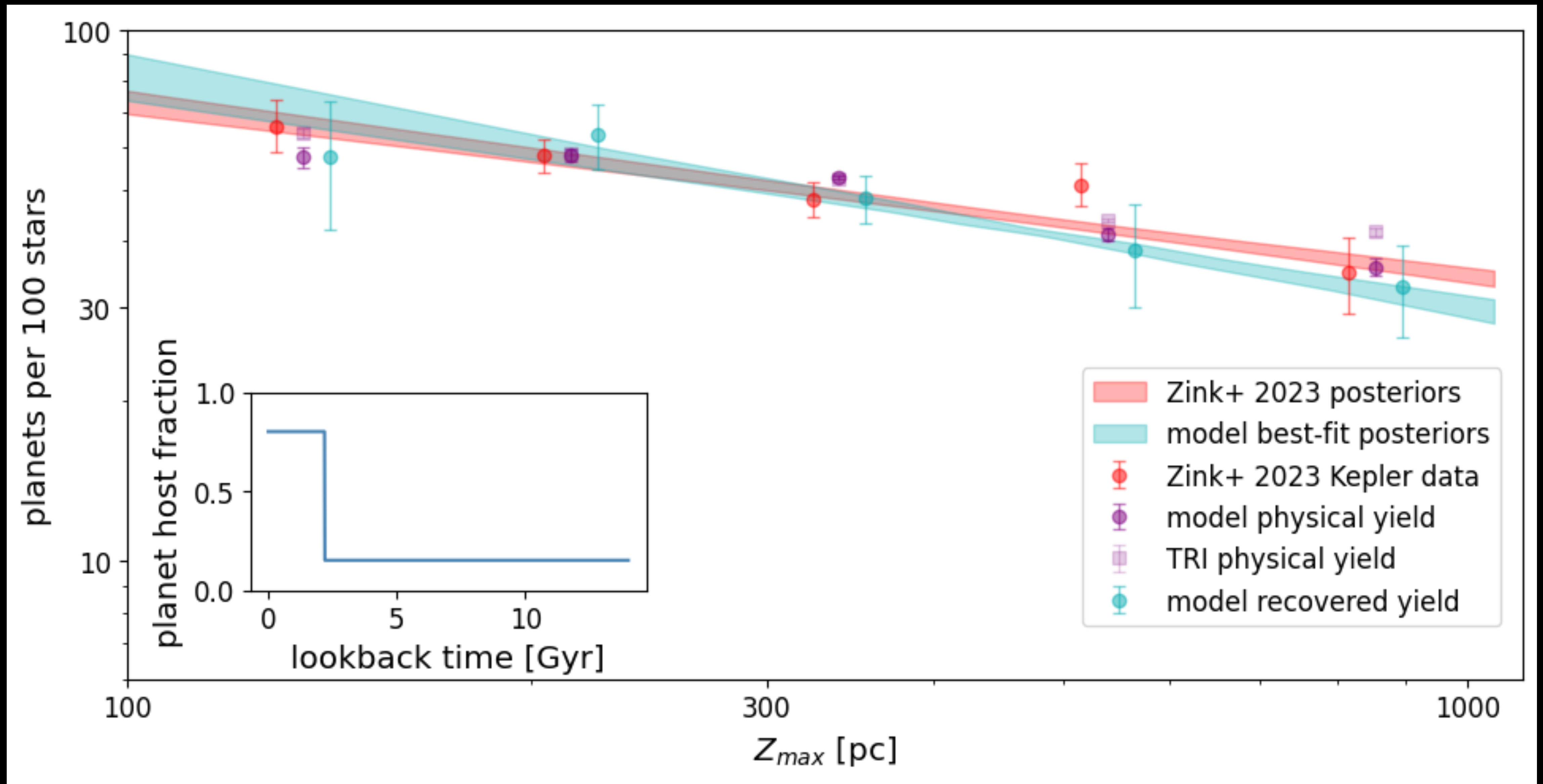
- Across order, there are no discernible peaks in the initial period distribution near the final resonances (plot above is for second-order).
- The initial periods of different orders have statistically indistinguishable initial period ratios. Most higher-order MMR must undergo substantial migration.

A Late-Time Rise in Planet Occurrence Reproduces the Galactic Height Trend in Planet Occurrence

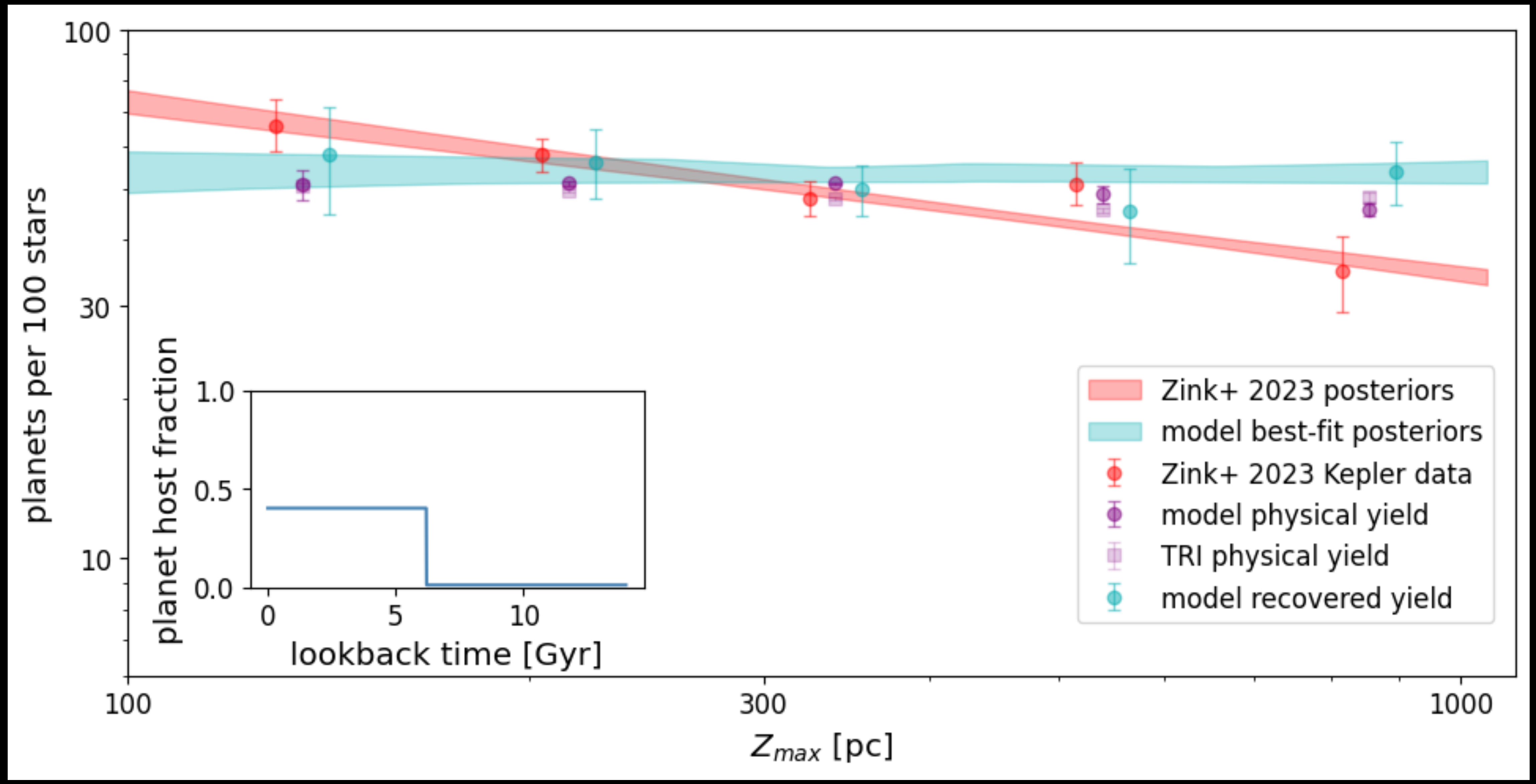


Christopher Lam | University of Florida | c.lam@ufl.edu | Sagan Workshop 2025 Poster Pop

Late-time rise in planet occurrence: matches Kepler!



Earlier-time rise in planet occurrence: doesn't match Kepler



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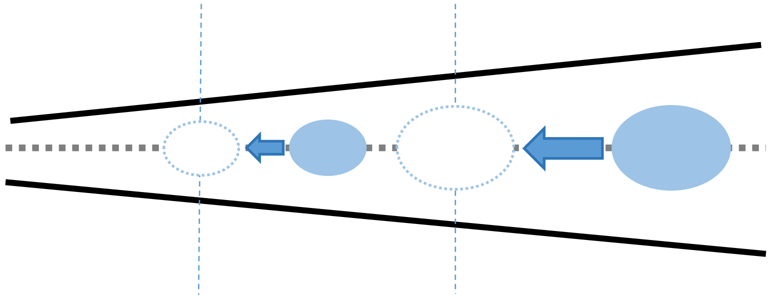
Resonance trapping and stability during Type-I migration

Linghong Lin
Zhejiang University

Type-I migration



$\tau_a -$ *migration timescale*

$\tau_e -$ *eccentricity damping timescale*

Free parameters

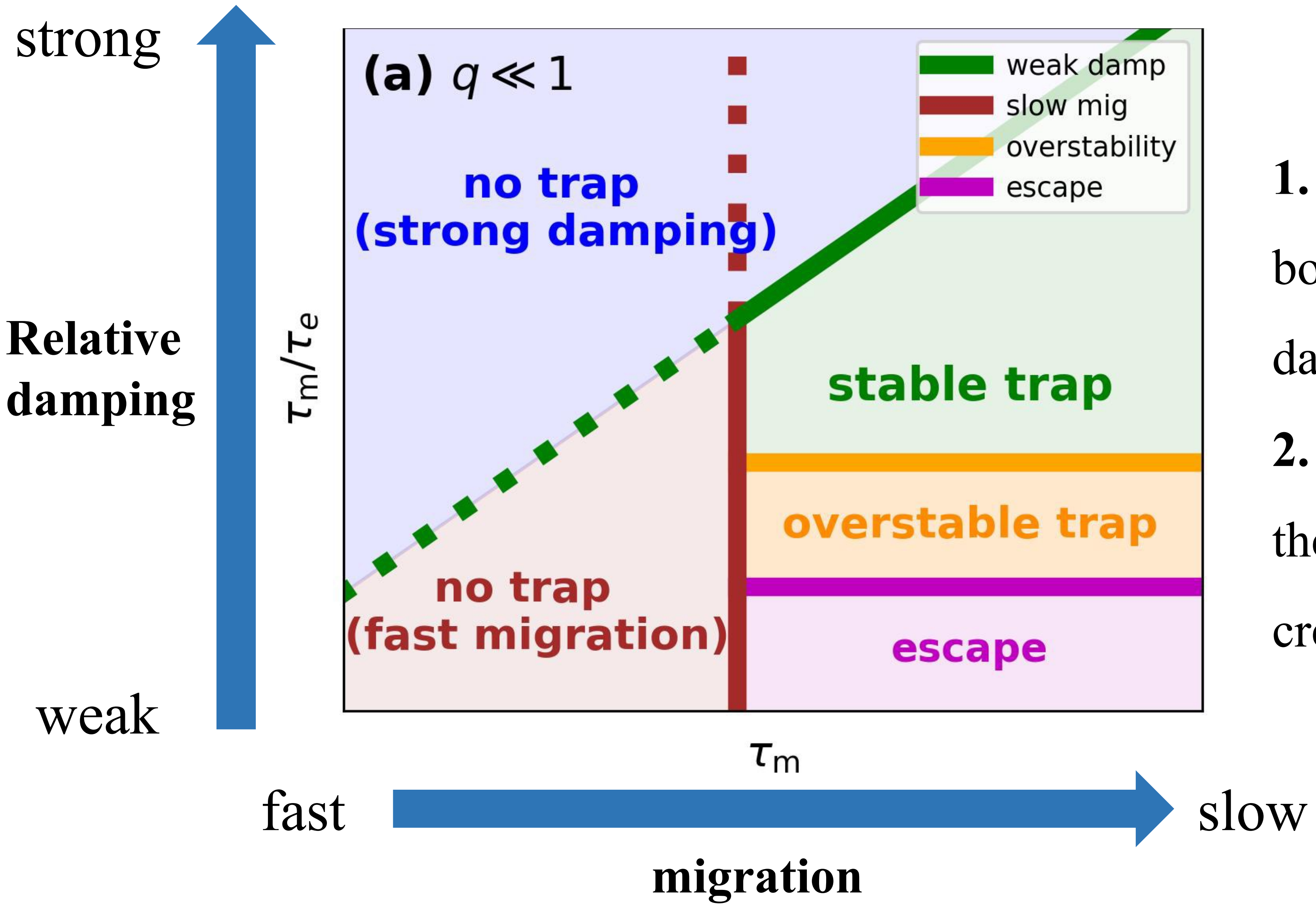
Mean motion resonance (MMR)

- $\frac{P_o}{P_i} = j\colon j-k$ (e.g, 2:1)
- Resonant angle φ at a fixed value

$$\varphi = j\lambda_o - (j-k)\lambda_i - k\varpi_{o,i}$$

Convergent Migration can lead to MMR trapping

Key result



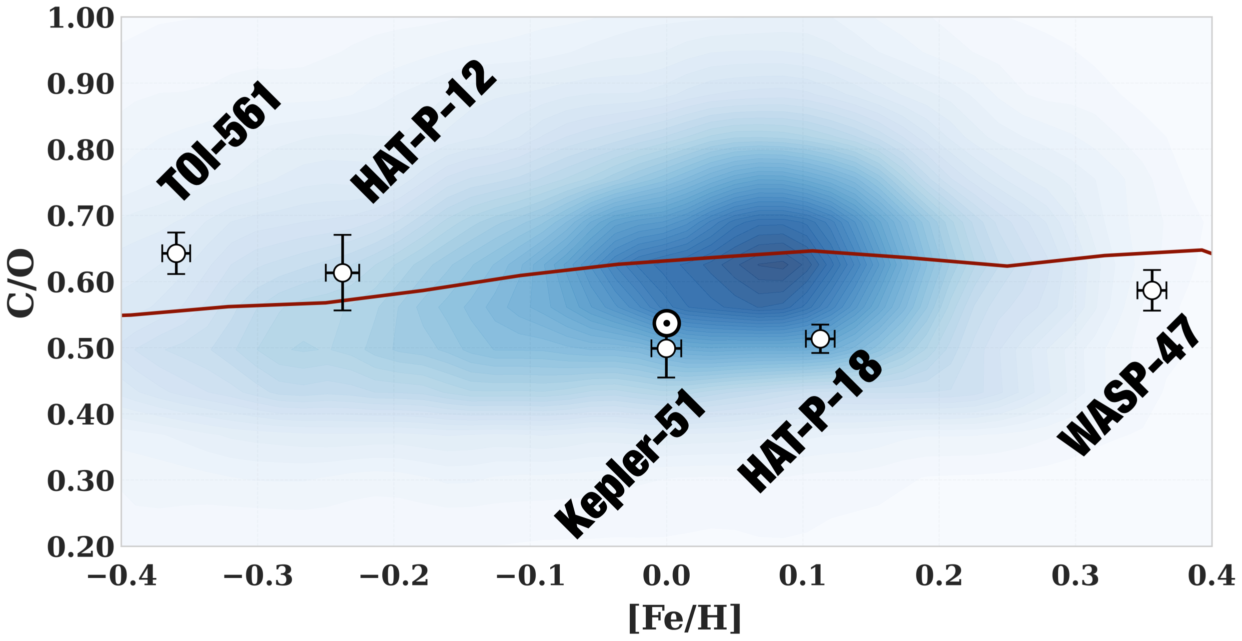
Take home message

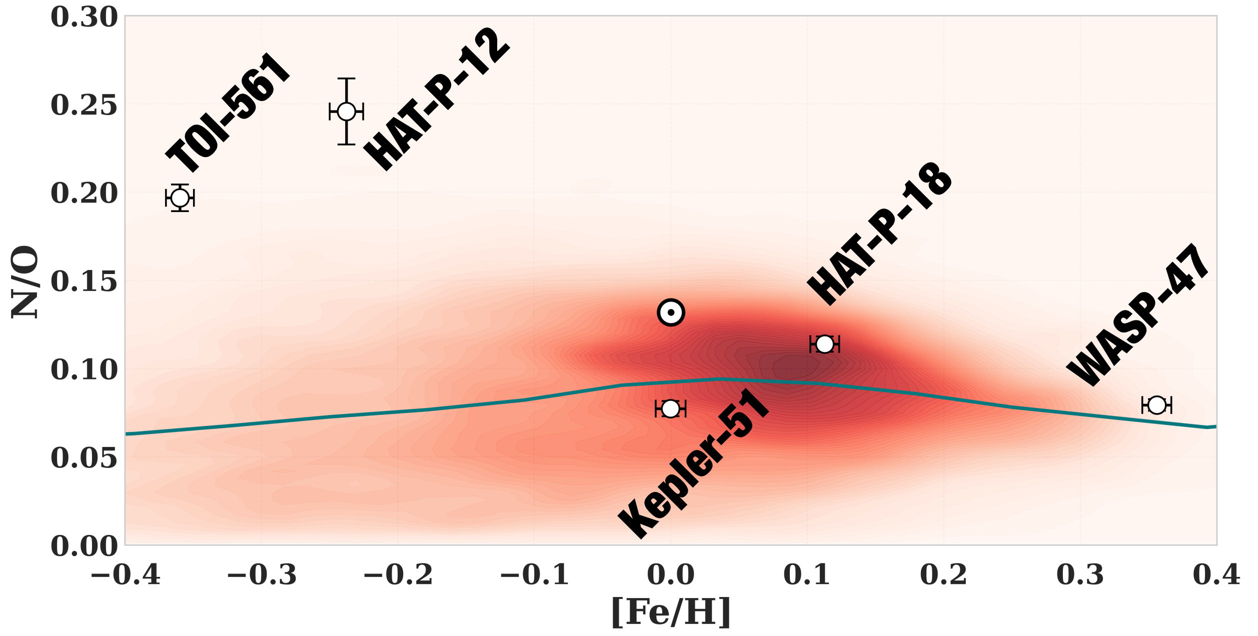
1. Resonance trapping requires both relatively weak eccentricity damping and slow migration.

2. After trapping, the stability of the system weakens as τ_m/τ_e decreases

Accurate, Precise, and Homogeneous Exoplanet Host Star Parameters

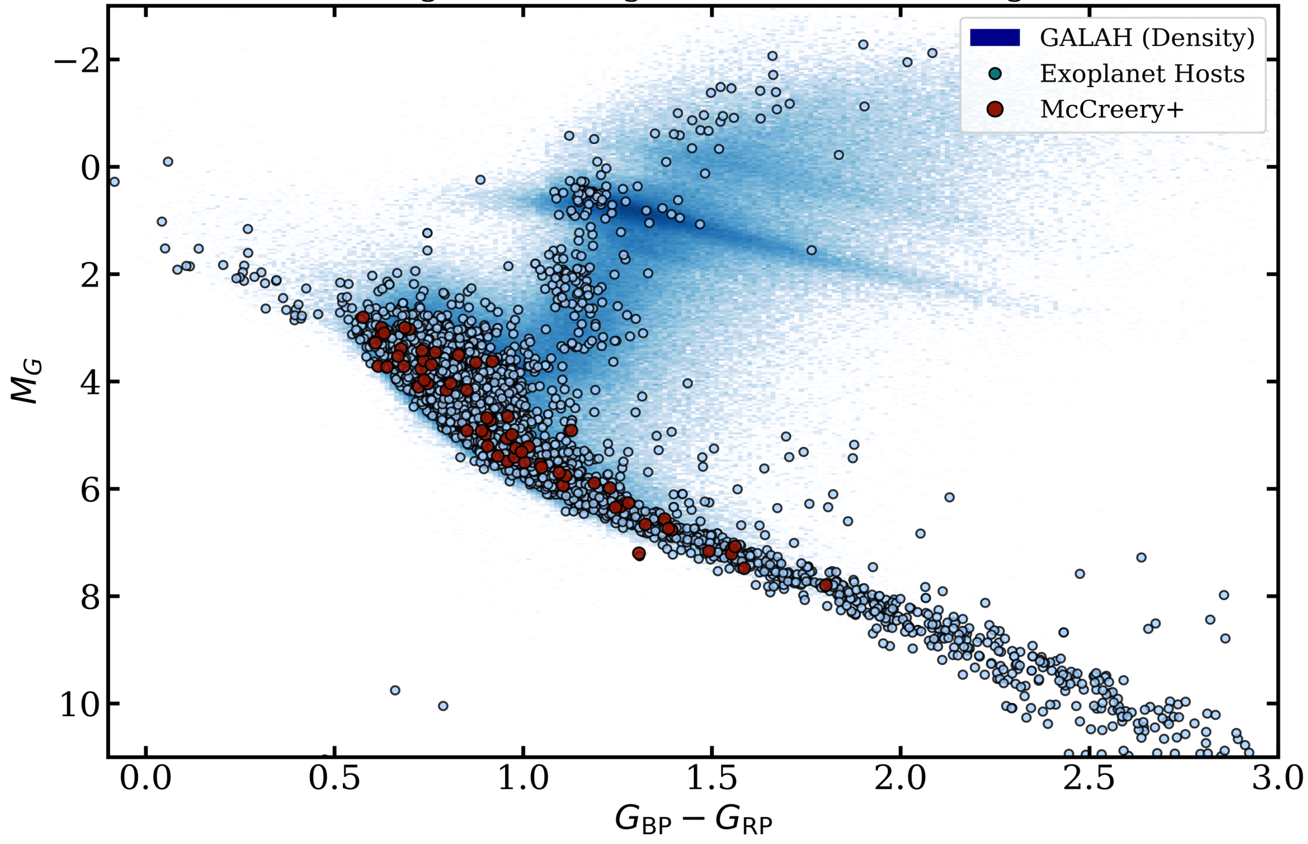
Patrick McCreery, Kevin Schlaufman, Henrique Reggiani
Johns Hopkins University
pmccree2@jh.edu





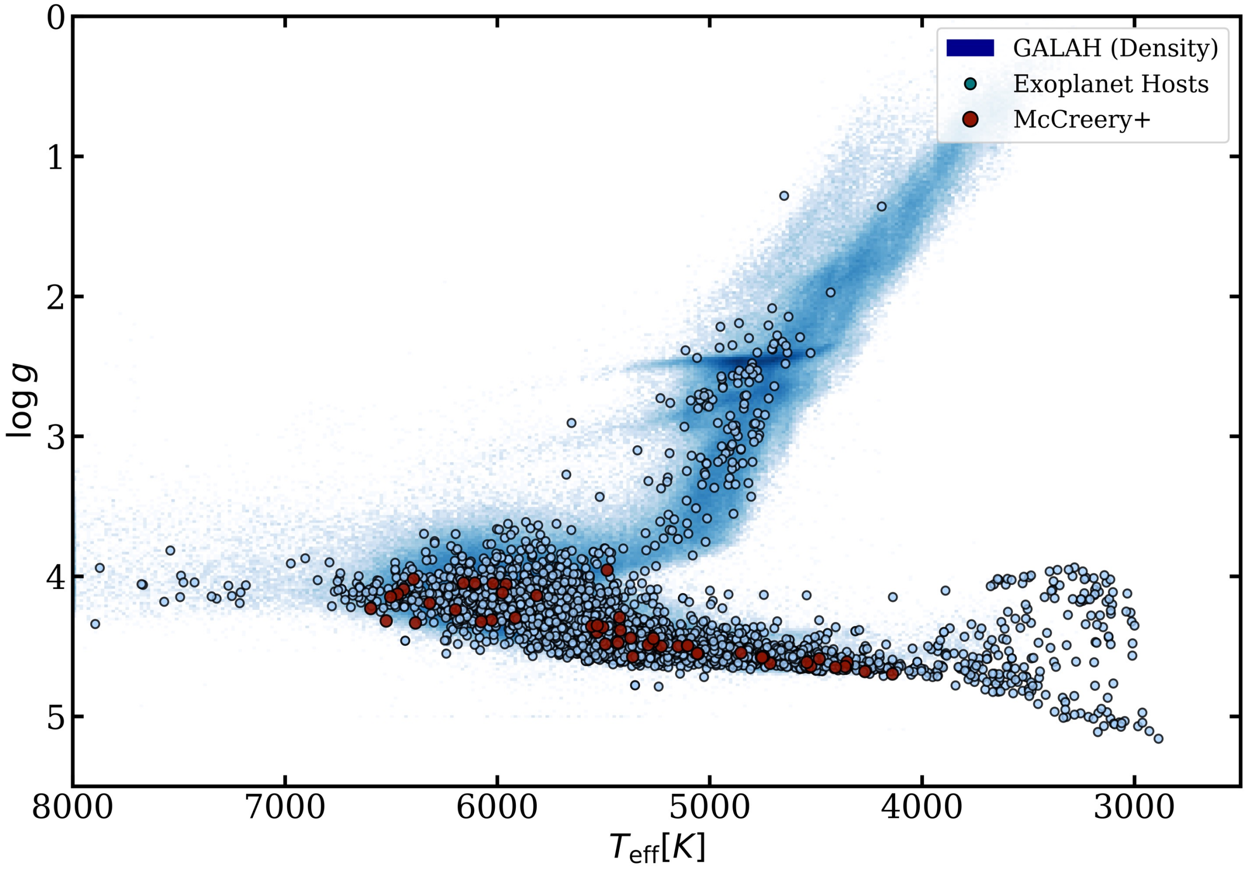
The recent release of SDSS-V DR19 shows significant diversity in stellar compositions — exoplanet host stars often deviate from solar abundances.

Accurate host star characterization is critical for interpreting exoplanet atmospheres and formation histories.



Combining high-resolution spectroscopy with photometry yields accurate, precise stellar parameters and photospheric abundances.

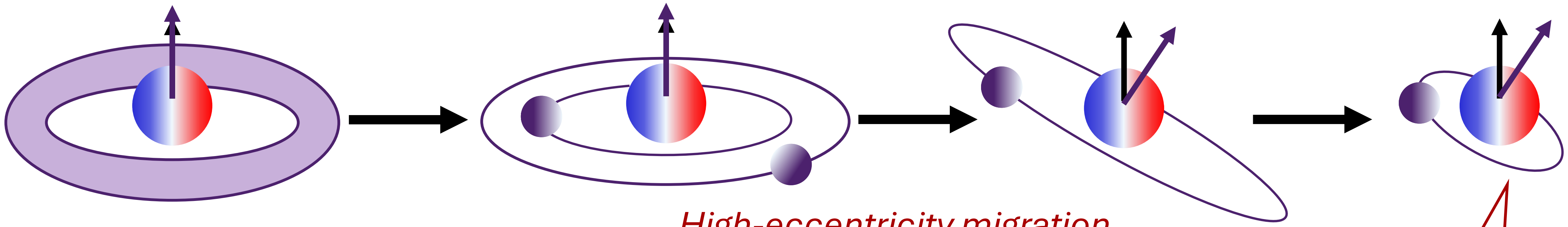
The inferred stellar characteristics (e.g., effective temperatures and radii) are statistically consistent with direct interferometric measurements.



Stellar Obliquity As a Tracer of Evolution

Misaligned Hot Jupiters & sub-Saturns* – Nature or Nurture? *in single-star systems

Nurture: Post-disk Misalignment

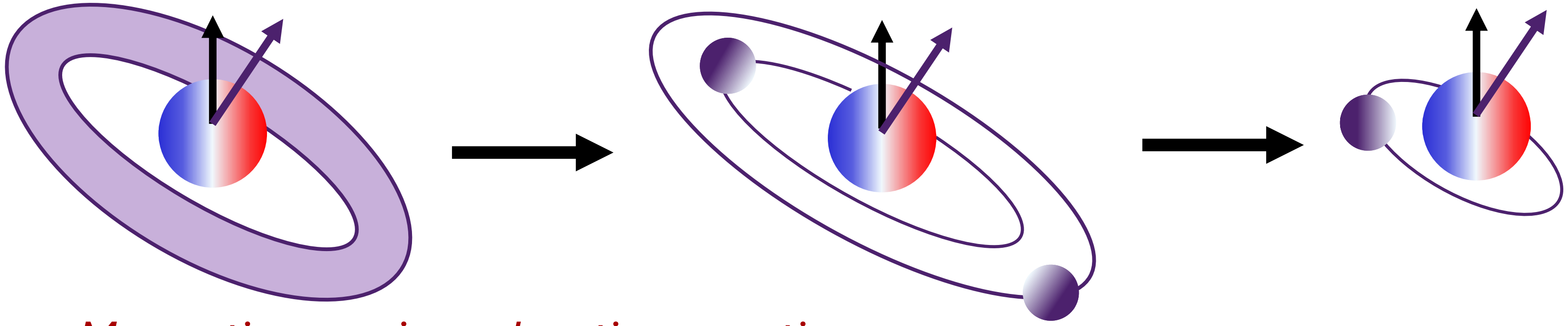


High-eccentricity migration

Fabrycky & Winn 2009 *ApJ* **696** 1230

Nature: Primordial Misalignment

See, e.g., Davies *et al* 2019 *MNRAS* **484** 2 1926–1935



Magnetic warping, chaotic accretion

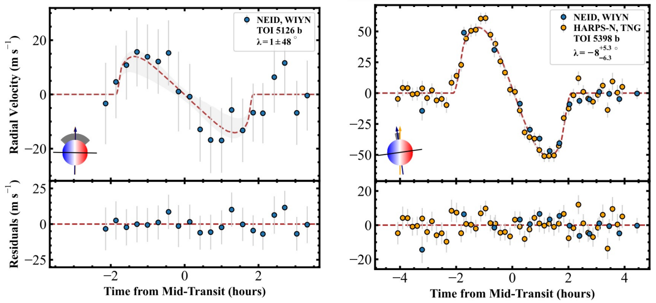
Bate *et al* *MNRAS* **401** 3 1505–1513; Romanova *et al* 2021 *MNRAS* **506** 1 372–384

Use **compact multi-planet systems** to study the primordial disk plane!

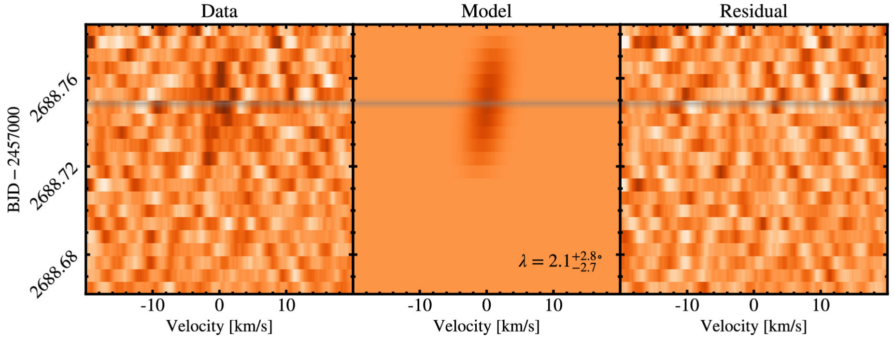
Evidence for Primordial Alignment:

Insights from Stellar Obliquity Measurements for Giants in Compact Systems

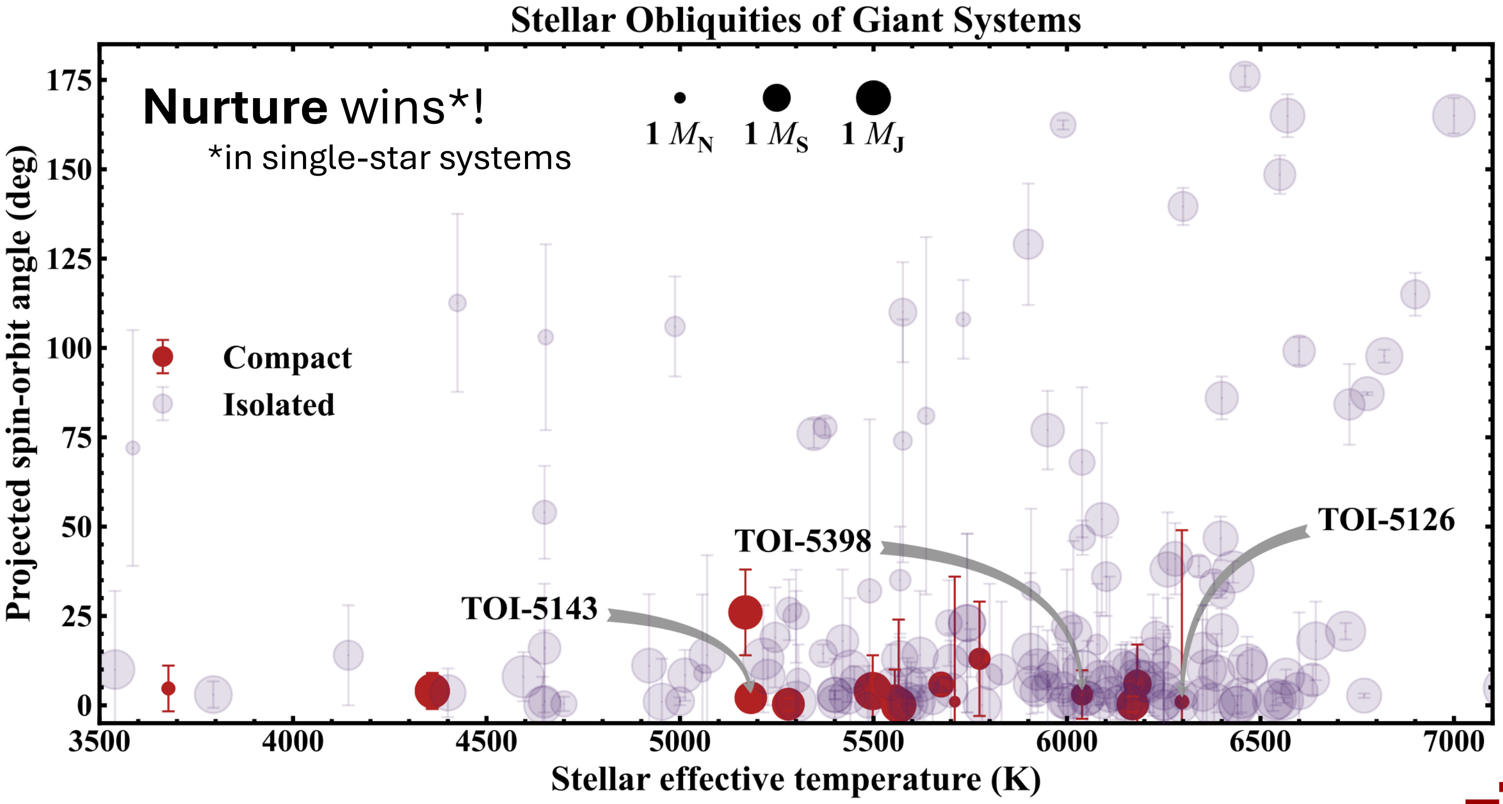
Rossiter-McLaughlin measurements reveal two **compact sub-Saturns and a hot Jupiter in alignment,** supporting 1) *high-e migration* in misaligned systems and 2) *quiescent disk migration (or in situ origins)* for compact systems

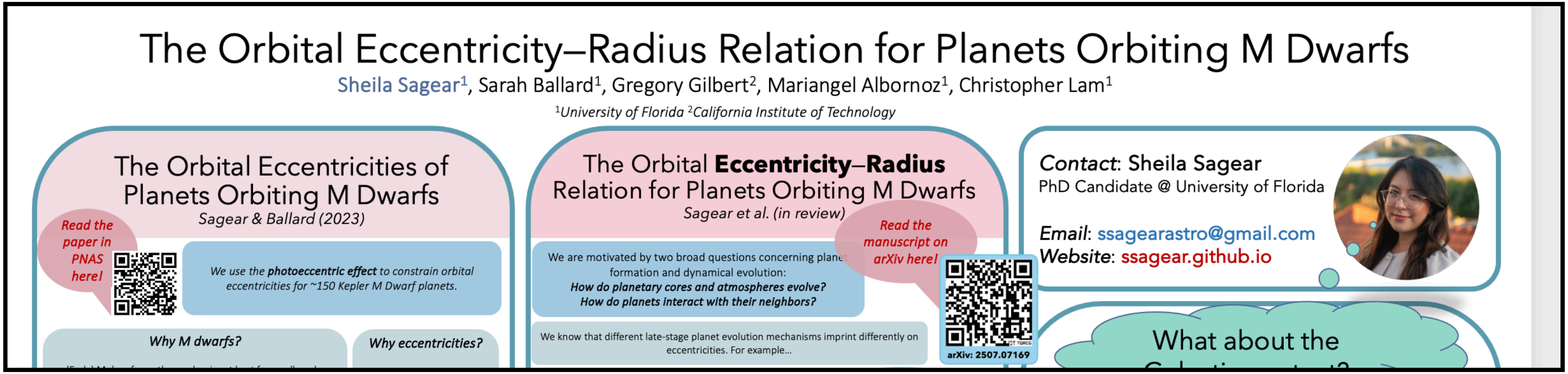


Radzom *et al* 2024 *AJ* **168** 116



Radzom *et al* 2025 *AJ* **169** 189





We explore the orbital dynamics of planets orbiting ***early-to-mid M dwarfs*** (the predominant rocky planet host) within a demographic framework.

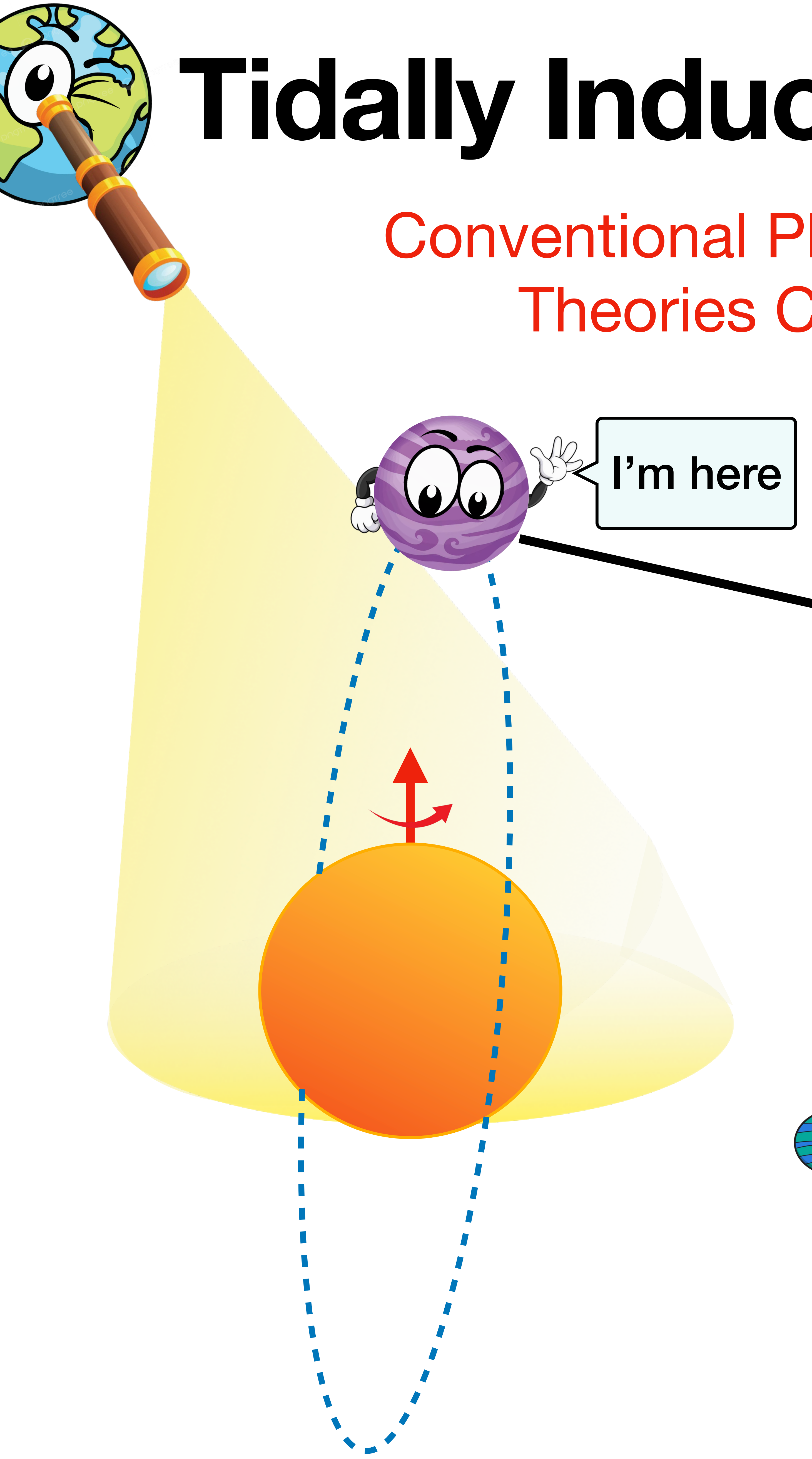
We find that ***small super-Earth (-) sized*** M dwarf planets have ***low*** eccentricities, and ***large sub-Neptune (+) sized*** M dwarf planets have significantly ***higher*** eccentricities.

This suggests *two distinct formation/dynamical evolution pathways* are at play for M dwarf planets!

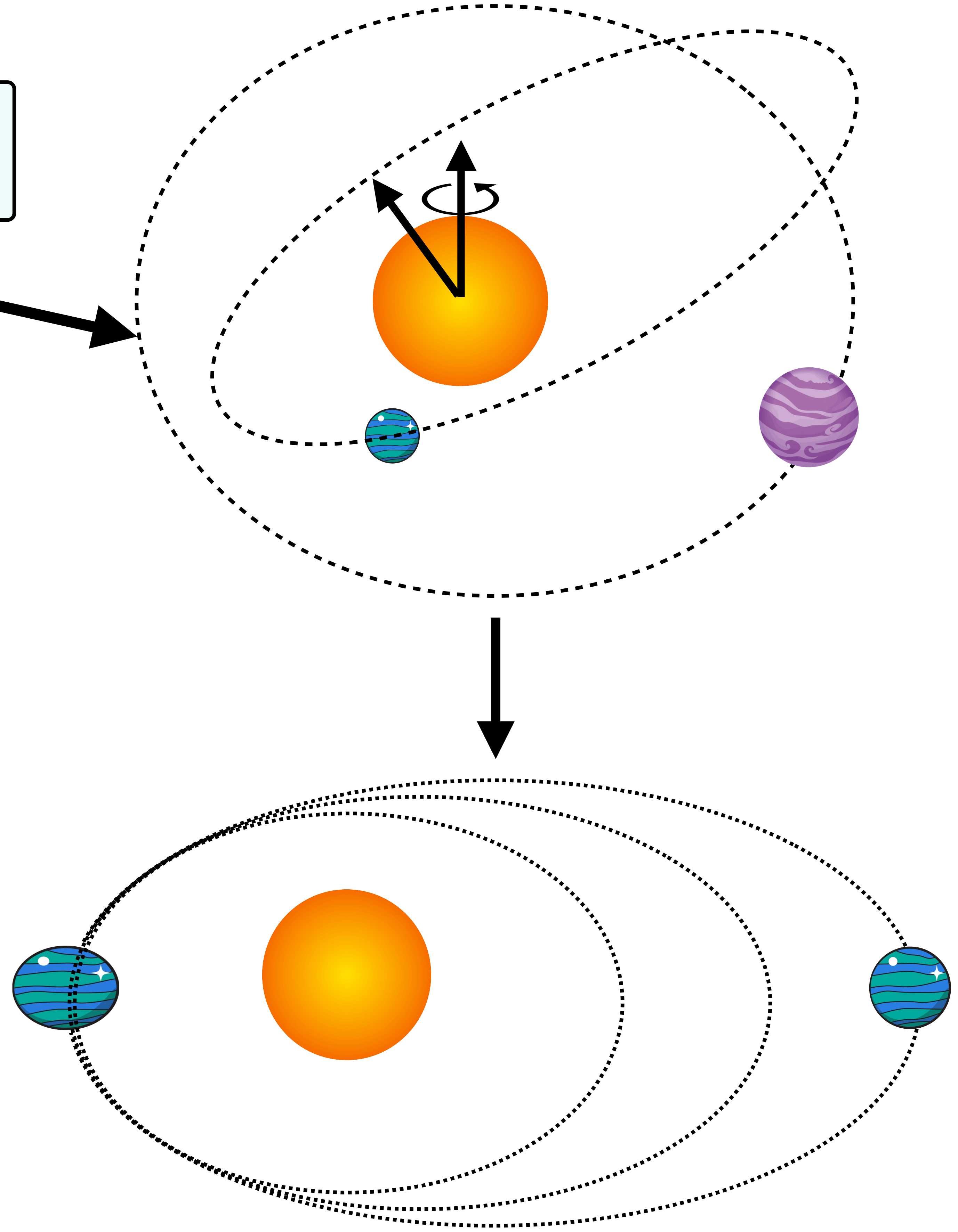
We explore the implications of the ***Galactic context!*** (Stellar flybys? Galactic dynamics? Stellar ages?)

Tidally Induced Radius Inflation in “puffy” Planets

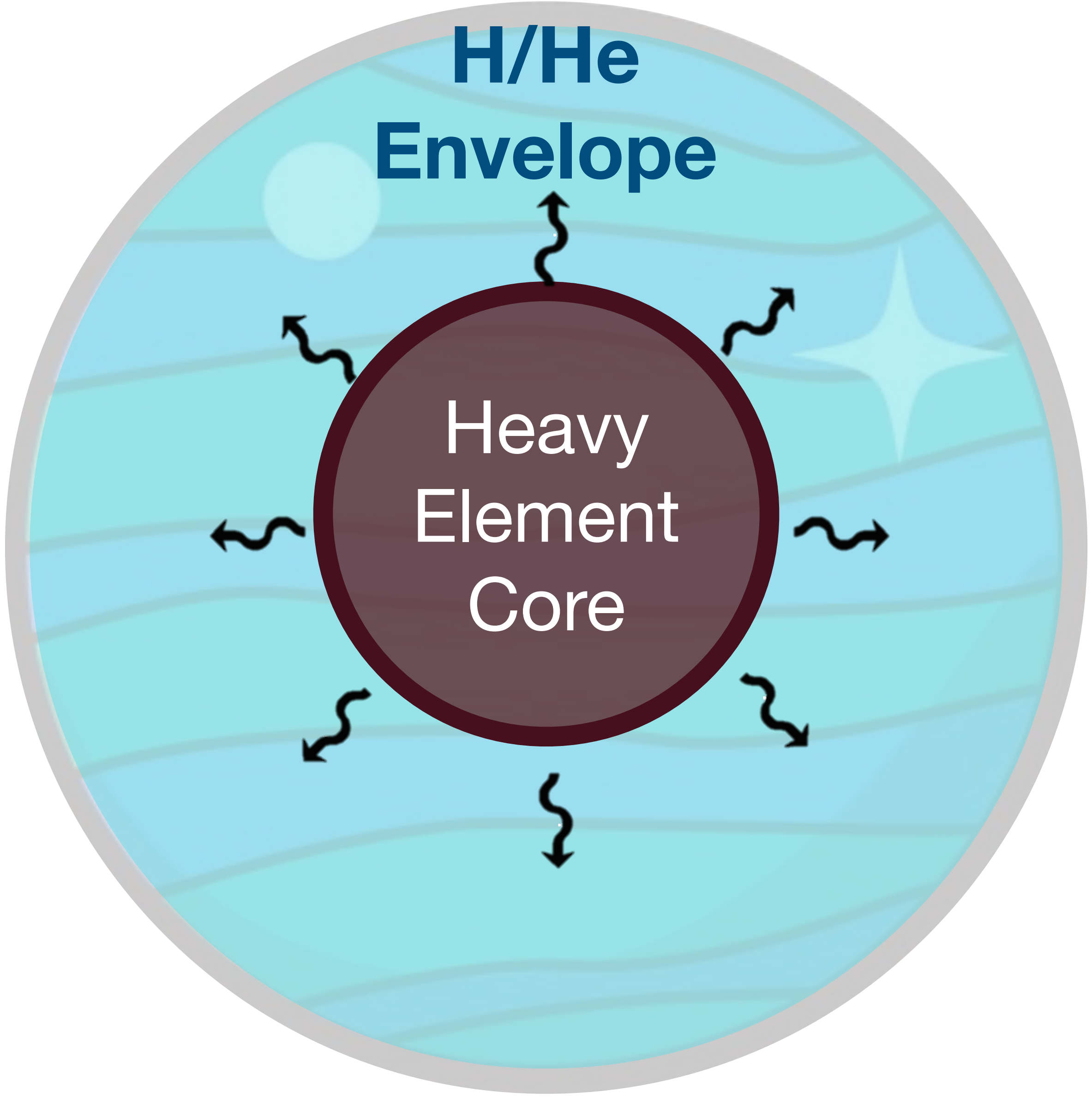
Conventional Planet Formation
Theories Challenged!



“Polar” Planets

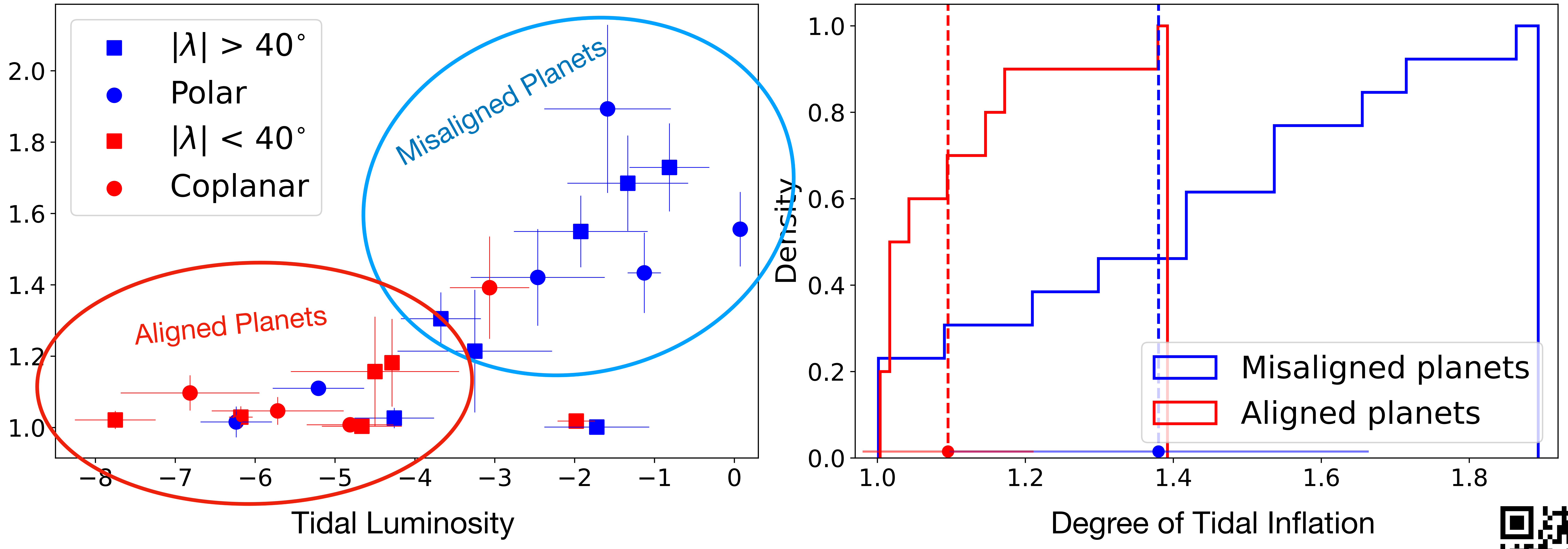


Planet-planet Scattering or ZLK
Oscillations might have driven them to
highly misaligned and eccentric orbits,
followed by tidal dissipation



Radius Inflation

Misaligned Planets are More Inflated Than Aligned Ones!



Sethi & Millholland 2025 (Accepted)